# Jinchuanwan Grotto

# Jinchuanwan Grotto

## Annual Report 2007–2009

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**Technische Universität München,**
**Lehrstuhl für Restaurierung, Kunsttechnologie und Konservierungswissenschaft**

**Xi'an Center for the Conservation and Restauration of Cultural Heritage**

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# Einleitung/Introduction

**Zhao Zhou, Mathias Kocher**

Bei der Sitzung des Deutsch-Chinesischen Lenkungsausschusses in Xi'an wurde im Frühjahr 2006 beschlossen, die bisherige erfolgreiche Zusammenarbeit zwischen Deutschland und China auf dem Gebiet des Kulturgüterschutzes inhaltlich und auch geografisch auszuweiten. Auf Vorschlag der chinesischen Seite wurde die Restaurierung der buddhistischen Kulthöhle in Jinchuanwan aufgenommen und für die nächste Projektphase projektiert.

Die Grotte befindet sich westlich des Dorfes Jinchuanwan (金川湾, „Goldflüsschenbucht") in der Provinz Shaanxi, im Landkreises Chunhua (淳化县), ca. 100 km nordwestlich von Xi'an (N34º44'35'', E108º41'02''), am Fuß eines Berges.

Der historische Eingangsbereich der Grotte ist nicht mehr erhalten. Zum Schutz und zur Erhaltung der Anlage wurde der Eingang mit einer Ziegelfassade verschlossen (Abb. 6).

Die Grotte ist eine Steinkammer mit nahezu rechteckigem Grundriss und flacher Decke. Diese etwa 7 x 5 Meter messende Höhle aus dem 7. Jahrhundert ist bemerkenswert, weil ihre Seitenwände gänzlich mit buddhistischen Texten bedeckt sind. Über 60.000 Schriftzeichen sind noch erhalten.

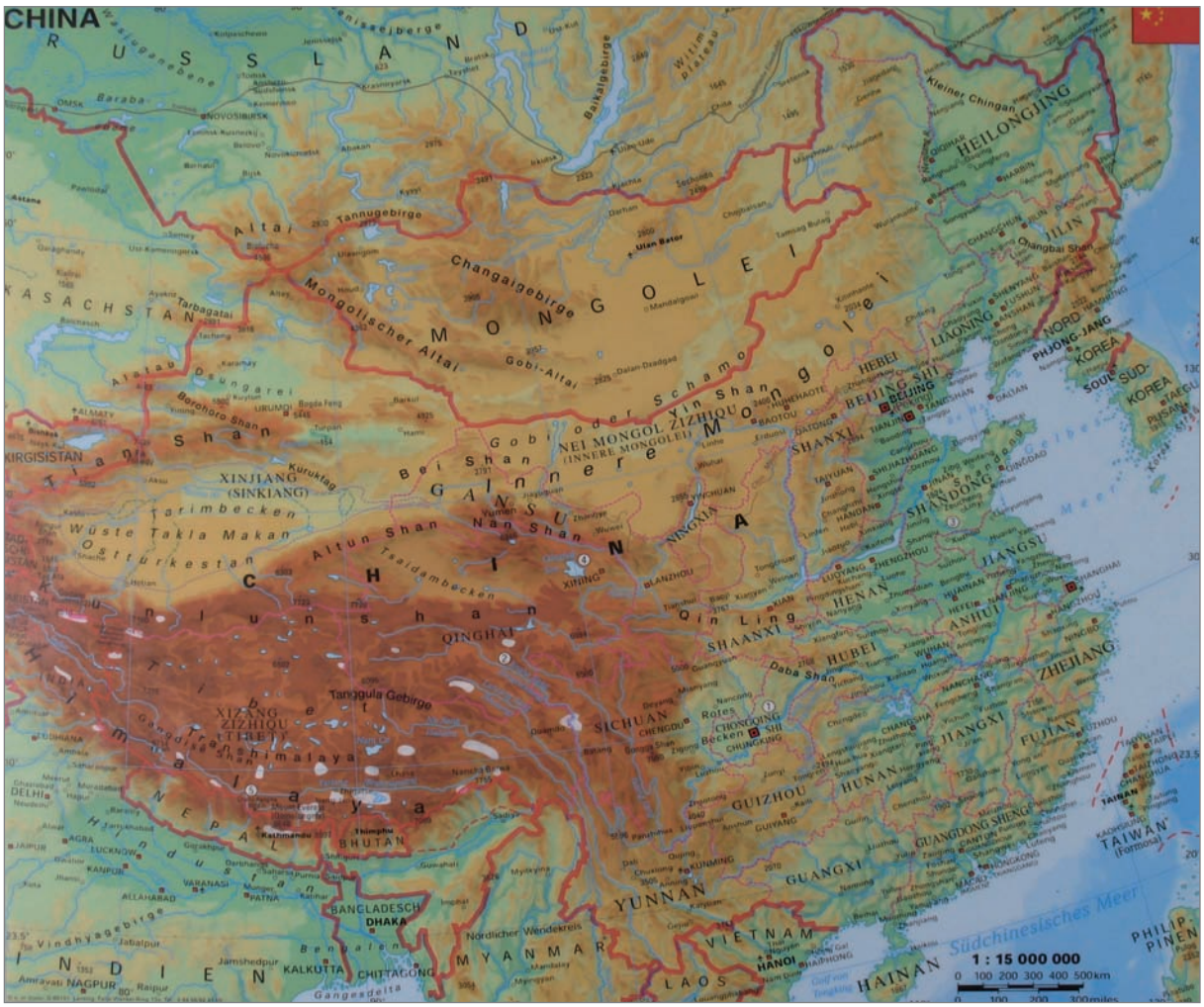


**Abb. 1:** Geografische Karte Chinas

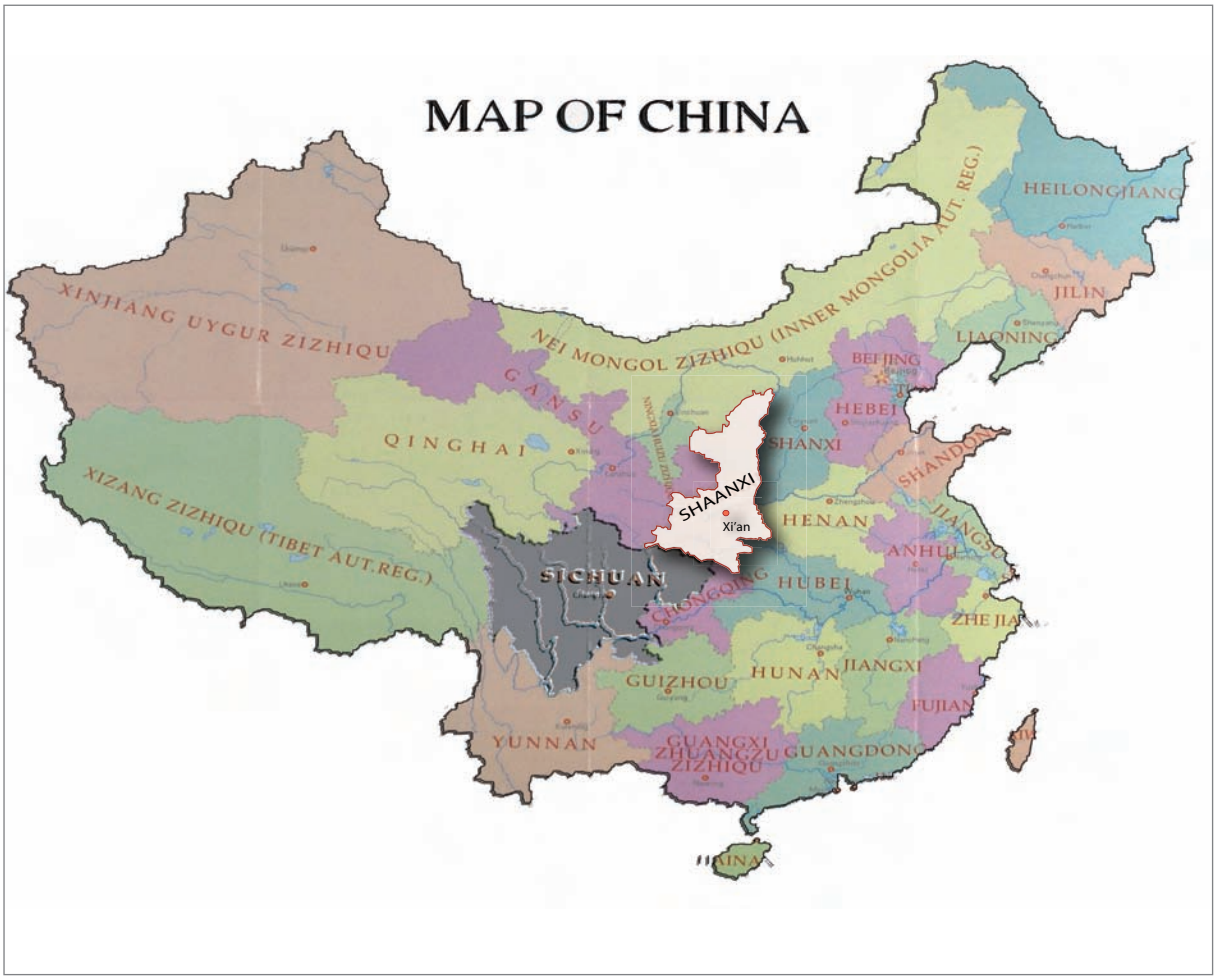


**Abb. 2:** Die Provinz Shaanxi in Zentralchina

**Abb. 3:** Lage der Grotte Jinchuanwan

**Abb. 4:** Übersichtsaufnahme der Region um die Grotte

**Abb. 5:** Das Flüsschen Jinchuanwan

**Abb. 6:** Eingangsbereich der Grotte

Die sitzende Buddhafigur vor der Rückwand ist eine Rekonstruktion aus neuerer Zeit. Sie ist die einzige Skulptur in der Grotte. Ursprünglich standen noch zwei Begleitfiguren aus Ton neben der Figur.

Die Texte in der Höhle von Jinchuanwan sind von besonderem historischem Interesse, stammen sie doch von Xinxing (540–594), der eine neue Schule des Buddhismus gründete. Diese wurde schon kurze Zeit später wegen ihrer politischen Radikalität unterdrückt. Nur hier existieren noch drei längere Texte dieser Lehre, die ansonsten in China nicht mehr überliefert sind. Sie wurden erst in den 1990er Jahren wiederentdeckt. Insgesamt waren etwa 160.000 Zeichen (Höhe 1,5 bis 1,8 cm) in die Seitenwände der Grotte gemeißelt, etwa ein Drittel, ca. 60.000 Zeichen, sind heute noch erhalten.

Insgesamt sind acht Sutras, vier auf der östlichen und vier auf der westlichen Seitenwand, überliefert. Die vier wichtigsten Texte der Drei-Stufen-Lehre sind relativ gut erhalten.

Die östliche Wand enthält insgesamt elf Register, die untersten drei beinhalten Texte des Mönches Xinxing,

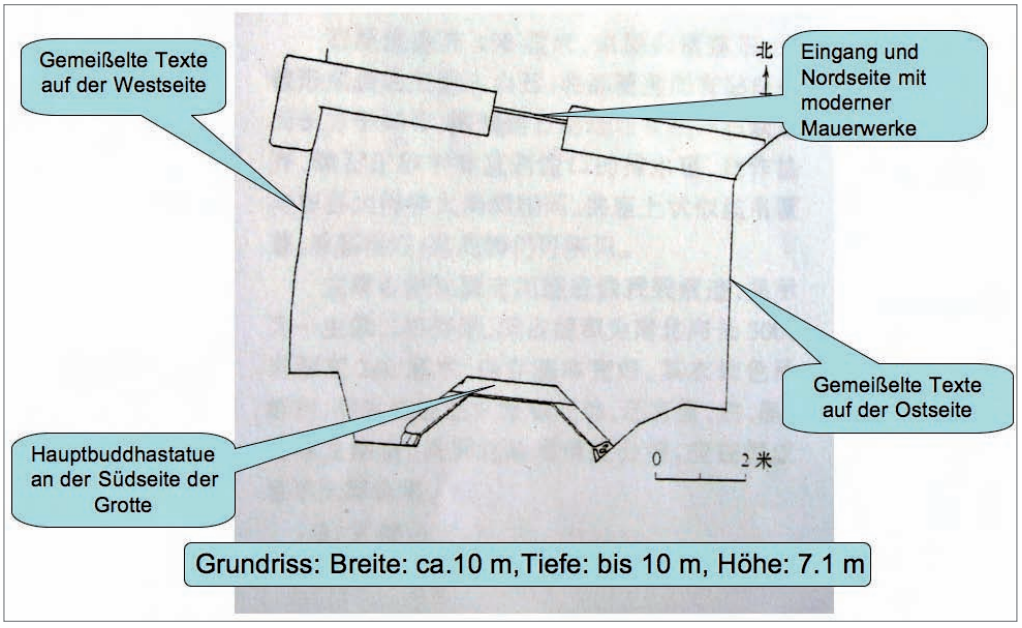


**Abb. 7:** Grundriss der Grotte

**Abb. 8:** Buddhastatue im Zentrum der Grotte

auf je einem Register. Es sind Erläuterungen, der in allen Sutras enthaltenen Methoden, im Einklang mit der Erkenntnisfähigkeit, sein Herz auf die Erleuchtung hin auszurichten 明諸經中對根起行發菩提心法, sowie Erläuterungen, der in allen Mahāyāna-sutras enthaltenen Methoden, wie Laien und Mönche ihr Herz auf die Erleuchtung ausrichten können 明諸大乘修多羅中世間出世間兩階人發菩提心法.

Auf der westlichen Wand sind insgesamt sieben Register erhalten. Im unteren Teil befinden sich drei kürzere Sutras; die erste dieser drei Sutras ist von Xinxing und nur noch teilweise erhalten.

**Abb. 9:** Ostwand der Grotte

**Abb. 10:** Westwand der Grotte

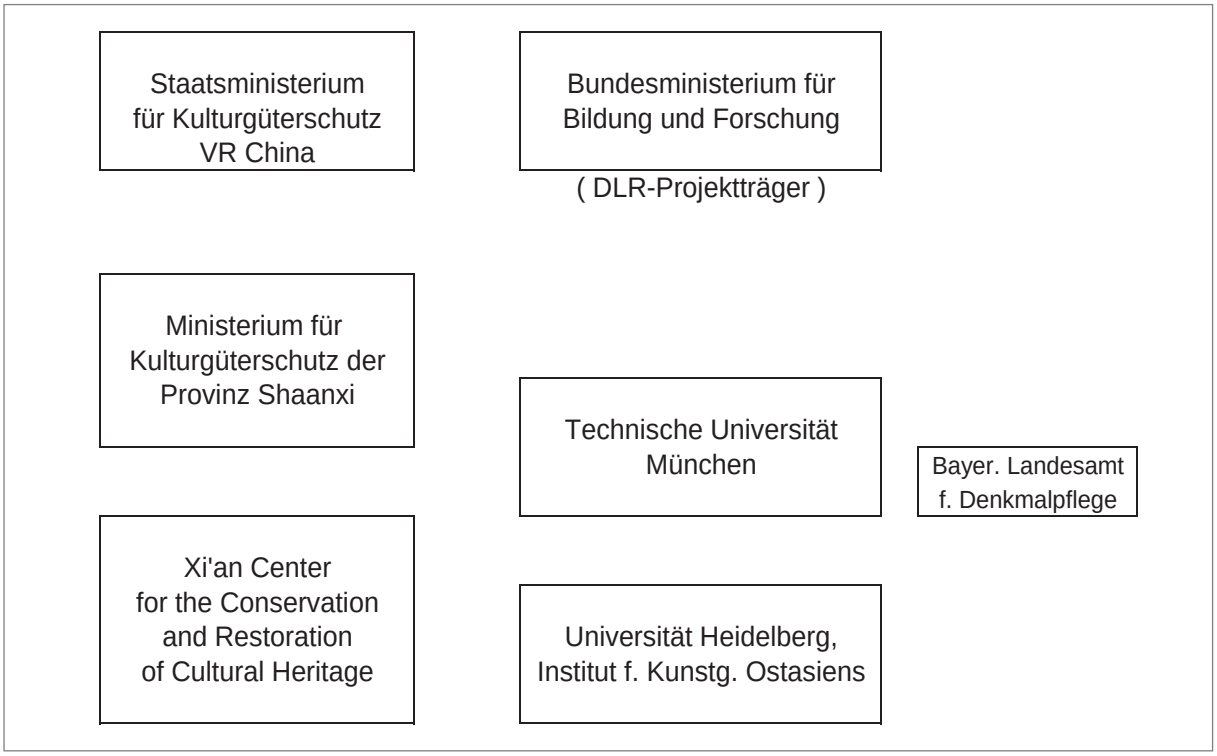


**Abb. 11:** Die beteiligten Institutionen

## Arbeitsaufenthalt Jinchuanwan

*6. bis 13. September 2009*

Untersuchung der Grottenanlage und Entwicklung eines Maßnahmenkonzeptes für die Restaurierung. Schadenskartierung der Ostwand sowie Festlegung und Anlage einer Musterfläche für die Gesteinsfestigung.
Teilnehmer: Dipl.-Restauratorin Martina Klukas (BLfD) und Dr. Mathias Kocher (TU München), Herr Yan Min und Herr Wang Yongjin.

Ein Treffen und ein gemeinsames Abendessen fanden mit dem neu berufenen Direktor des Zentrums Prof. Zhang Yinglang statt.

Der Arbeitsaufenthalt diente in erster Linie der Entwicklung eines Gesamtkonzeptes für die Restaurierung der Anlage. Das für das Gestein im Labor getestete Festigungsmittel wurde an zwei Musterflächen aufgebracht, und erste Versuche zur Hinterfüllung und Fixierung von hohl liegenden Schalen wurden durchgeführt. Nach den Wintermonaten sollen die angelegten Testflächen beurteilt und auf Dauerhaftigkeit geprüft werden.

# The Jinchuanwan Cave, Shaanxi, China, and the Carved Texts by Xinxing (540–593)

**Fig. 1:** Overview of the Jinchuanwan Cave

# The Jinchuanwan Cave and the Carved Texts by Xinxing (540–593)

**Zhao Zhou**

## Introduction

In the second half of the 6th century, the Buddhists in China believed that they were in the worst and last period of time after Buddha's nirvana, which was called "mofa". In this period, the capacity of human beings to receive Buddha's Teachings was so degenerated that it was not appropriate for them to follow the usual practices any more, in order to be salvaged from the suffering world. The Teaching of the Three Stages (*Sanjiejiao* 三階教), which was built on the very fundaments of time, capacity and teaching, offered a feasible solution, namely "to practise in accord with the capacity", and in such a way that one should arouse the mind to enlightenment, or, be resolved to achieve Buddhahood as the first and most important step for Buddhists.

Though the Teaching of the Three Stages saw its success and popularity in the Sui (581–618) and early Tang Dynasty (618–907), it was suppressed in the end since the eccentric theory and extreme practices were not consistent with the policy of the ruler. After the Tang Dynasty, this Buddhist movement was extinguished completely. The numerous treatises written by the founder Xinxing (信行 540–593) were also regarded as heretic and thus banned from the orthodox Buddhist canon. Today we only know the Teaching of the Three Stages by means of a few extant materials, primarily the manuscripts discovered in Dunhuang and some Buddhist temples in Japan at the beginning of the 20th century.[1]

In recent years, a small stone cave was rediscovered, in which, amongst others, four texts "compiled by the meditation master Xinxing" are carved on the walls. Three of the four texts are especially valuable material for the study of the Teaching of the Three Stages, as they are not available otherwise. The main text is the *Abridged Excerpts from the "Chapter of Moon Storehouse" of the Great Collection Sutra*, and the chapter was the main scriptural source for the belief of "mofa". The other two texts are focused on "arousing the mind to the enlightenment in accord with the capacity".

Unquestionably, those materials will bring us new light to the study about the extinct Buddhist movement.[2]

## The Cave

The Jinchuanwan Cave is named after the nearby village, which is located 100 km northwest of the city Xi'an. Carved at the foot of a hill facing a small river to the north, the cave is about 10 metres wide, 10 metres long and 7.1 metres high (Fig. 1).[3]

The original entrance, together with the northern wall was destroyed a long time ago and was recently rebuilt with grey bricks (Fig. 2).

Upon entering the cave, one sees the huge statue of Buddha directly on the front southern wall, and on the eastern and western sidewalls various Buddhist scriptures can be read. The huge Buddha is the only statue in the cave (Fig. 3). The statue was almost totally destroyed during the Culture Revolution of the 1970's. (The present statue is a reproduction in the style of the old.) Presumably, there might have been assisting figures on the both side of the Buddha, but they are also totally ruined. The only original remaining sculptures in the cave are the seven small Buddha figures decorating the halo behind the main statue, though they are also to certain extent weathered (only six remain, Fig. 4).

Generally on each layer of both walls one scroll of text was carved, which consists of about 10.000 characters. Altogether 160.000 characters have been carved in total, on nineteen layers. Due to more than a thousand years of weathering however, only around one third is legible. On the both sidewalls there are altogether eight texts carved, each side four. On the eastern wall are eleven layers (Fig. 5): beginning from the bottom, one reads the three texts compiled by Xinxing on the first three layers.

Above them from the fourth layer is a whole scripture, *The Great Collective and Extensive Sutra of Ten Wheels*, which is arranged on one layer with approximately one scroll to the top of the cave. On the western wall, there are eight layers and four texts (Fig. 6): on the first level are three short texts, one by Xinxing, the *Diamond Sutra* and *Sutra where Tathāgata Reveals Teachings to King Prasenajit* and from the second layer is the whole text of the *Lotus Sutra*. From the inscription together with the *Diamond Sutra* we know that the cave must have been carved during 662–670 in the Tang Dynasty (618–907).[4] It is also interesting to notice, that the texts of Xinxing, though written as treatises that were heretically inferior to the "true sutras" allegedly taught by Buddha, were put intentionally in the easily accessible places. That shows that Xinxing's texts are not only treasured by the historian of today, but were also highly valued at that time.

**Fig. 2:** Frontal view of the cave

**Fig. 3:** Buddha statue (reconstructed)

## The Four Texts by Xinxing (540–593)

The three texts by Xinxing, which are not delivered in Buddhist cannon or historical manuscripts, are about an important subject of the theory and practice of the Teaching of the Three Stages, "Arousing the mind to enlightenment". The texts concerning the theme are mentioned many times in historical documentations, but since the text itself has not been discovered, the theme has been unclear to the historian for many years until the publication of the manuscript P.2283 from Dunhuang in 1970.[5] However, the Dunhuang manuscript is partly damaged and can render only limited information. The two carved texts concerning "arousing the mind to enlightenment" reveal to us direct historical material for the first time about the original thoughts of Xinxing on the subject.

### *Sutra 1 – Clarifying the Methods in the Scriptures about Arousing the Mind to Enlightenment in Accord with One's Depth of Capacity*

One main characteristic of Xinxing's texts is the frequent and numerous quotations of the Buddhist scriptures. In this text, we find 34 titles of the quoted scriptures, among which 26 are scriptural names and 18 names of chapters. Xinxing quoted and reconstructed the excerpts from scriptures to build his own theory, by means of an extraordinary way of constructing.

In a manuscript from Dunhuang *Sanjie fofa miji* (P.2412), an exegesis about the *Sanjie fofa* of Xinxing by his disciples, it is cleared about the structure of Xinxing's most important work. It is explained that in the text there are four levels, namely sections (*daduan* 大段), parts (*duan* 段), subparts (*ziduan* 子段) and sentences (*ziju* 子句). Further as Xinxing himself has once explained, there might be still the levels between *duan* and *ziduan* and under sentence. Usually certain words were used such as *diyi* (第一 first), *zhe* (者 part) or *jie* (阶 stage) to mark the structure. However, in fact it is much more complicated, especially when the text is partly damaged, as the case in the Jinchuanwan Cave shows.

In the first text, it is explained in the very beginning, "Therein are four sections clarifying the significance." In the first section we find five levels; the second four levels; the third seemingly only three and in the fourth five levels. The following diagram shows the construction of the first section of this text, where the different levels are marked with numbering and different colours (Fig. 7):

The content of text, as explained in the title, is about "arousing the mind to enlightenment", which is clarified in four sections. 1. The dimension and degree to arouse the mind to enlightenment; 2. The dimension and degree of the cause to arouse the mind to enlightenment; 3. The capacity to receive the teachings; 4. The practices, which arise in accordance with the capacity.

**Fig. 4:** Detail: Buddha statue on the halo of the main Buddha

**Fig. 5:** Eastern wall

*Sutra 2 – Clarifying the Methods in the Scriptures of the Great Vehicle about the Difference of the Mundane and Transmundane Two Stages Persons Arousing the Mind to Enlightenment*

This text explains the methods of arousing the mind to enlightenment for the two stages of persons, namely those who leave their homes (the monks and nuns) and those stay at home (the laymen and laywomen). Xinxing defined the monks as "endowed with ten kinds of goods" and the layman as "endowed with ten kinds of evils". But in fact the persons with ten kinds of evils were his main concern. For the persons with ten kinds of goods he had only one sentence, "as extensively expounded in the *Flower Garland Sutra* and the scriptures and treatises of the Great Vehicle", but for the mundane persons he had written four parts: 1. Contemplating the emptiness; 2. Revering the sentient beings; 3. Revering all teachings; 4. Severing the evil to accomplish the good practice.

The third part is especially noteworthy. According to Xinxing's doctrine, that in the degenerated age the sentient beings have no capacity to learn Buddha's Teachings in a traditional way, but have to revere and learn all teachings. Based on the quotation from the *Nirvana Sutra* that "all various kinds of different theories, sorceries, languages and words are all the Buddha's teachings, not that of the heretics."[6] He did not differentiate the Three Vehicles (voice-hearers, solitary realizers and bodhisattvas) and the One Vehicle (the Great Vehicle), but also he included Confucianism and Taoism into the category of Buddhism. Thus, he expanded Buddhism to include all teachings, since he believed all those teachings were made for the goods and evils of the sentient beings. Xinxing's remarkable theory can thus be regarded as the earliest stage of the unified Three Teachings (*Sanjiao heyi* 三教合一) in China.

*Sutra 3 – The Abridged Excerpts from the "Chapter on Bodhisattva Moon Storehouse" of the Great Collection Sutra*

From a chapter of twenty parts actually only four were excerpted, the 16th, 17th, 19th, and 20th part, while the 16th and 20th part are mostly quoted. In comparison to the other complicated structured texts by Xinxing, this text has only one level, but thirty-one parts. In each part, it firstly clarifies the points and then the quotations of the scriptures, which are always marked by a sentence: "Above are the human words and below are scriptural texts."

The whole text can be divided into three sections. The first is from 1st to 11th part, wherein are ten kinds of persons who have the causes and conditions to become Buddha in the future. Actually, the ten kinds of "good" persons are quoted from a passage from the "Chapter on Forbearance and Humiliation", in which the World Honoured One praised the good sentient beings in the present and future world. Xinxing divided this continual passage into 10 categories of people.

In the second section, from 12th to 30th part, all scriptural texts are quoted from the same chapter as the first section. In this section, it is discussed about how to offer, sustain and protect the monks as well as how they should be punished if they break the precepts, especially those monks who have no precepts or have broken the precepts. In the 15th part it is stressed that even a king should not beat or curse the monks or rob the necessities from them. Possibly such narrations reflect the hard situations, which the Buddhist had to face in India.

The words from different periods after Buddha's nirvana are then quoted: the Five Hundred Years, which was later developed to the Buddhist cycle of periodization, the age of the True Teachings, Similar Teachings, and Latter Teaching or the degenerated age. The parables of various treasures and Buddhist believers are further discussed. Still it is about the discussion on how to deal with the monks, especially to those who have no precepts and those who have broken the precepts.

The third section is only one part, the 31st part, actually the direct quotation of the main verse from the "Chapter on the Extinction of the Teachings", which the main points of the chapter repeat. Though it is partly damaged, it can be verified that the whole verse is carved.

In this text, the points on how to treat the monks play a central role, which is consistent with the main content of the following *Sutra of Ten Wheels* on the eastern wall.

*Sutra 4 – Sutra of Buddha Names of Seven Rosters*

While the eastern wall was mainly dedicated to the teachings of Xinxing, the western wall seems to be reserved for the virtues and merits of sustaining Buddha's important teachings. On the western wall, there is only this short text of Xinxing carved. Nonetheless, the short text has a very important place in Xinxing's teaching, since it is the most important text concerning the ritual of worship of the Teaching of the Three Stages. As one of the earliest versions, it is unfortunate that the text was largely damaged. With the help of the delivered copy in manuscripts from Dunhuang with another name, "Text of Arousing the Vows in the Six Times of Day and Night", the remaining text is reconstructed.[7]

The whole text consists of two parts: The first part is the vow. The monks should seemingly arouse their vows after the form in the text. They should practice all various good deeds and with the merits, they wish all sentient beings to achieve the enlightenment. The second part is the procedure about how the monks worship the various Buddhas in the six times of a day and

night. The six times refer to the morning, noon, afternoon, evening, early night and later night, which originate from India and were combined with confession and worshipping by the Buddhists. In the procedure, there are approximately seven stages Buddha names to be chanted and worshipped, which gave the text its name. In the Cave Dazhusheng in Baoshan, Henan Province, the seven stages of Buddha names were also carved.[8] The seven rosters of Buddha names show a certain relation between the Buddhist thoughts and practices of the two caves and the relating renowned monks at the time.

It is remarkable that the texts by Xinxing are carved and arranged in such a way that the four texts might tell the pilgrim how to initiate one's mind to enlightenment and how to practise the ritual of confession and worshiping in accordance with the Teachings of the Three Stages.

**Notes on the translation**

Rather than a free paraphrase, the translator has decided a loyal translation of the original text. On the one hand, since each character has a specific meaning or function in the texts, it is attempted to make each character in the original text to have a counterpart in the English translation. Though the translation might sometimes read awkward, the translator hopes that the original meaning could be loyally rendered. On the other hand, the original texts carved on the stonewalls are to a certain extent badly damaged, so that numerous sentences cannot be understood or clarified. Thus, the literal translation is more practicable. All supplements by the transcriber or translator are marked with underlining the Chinese text. For characters and sentences which are not meaningfully understandable, they are just translated with the most possible words, which are stylistic consistent with the context as much as possible, and the sequence of those words remain unchanged. The unreadable character due to damage in the original are indicated by a blank box "□" which are also kept in the English translation, thus the reader could sense the content of the damaged passages through the literal translations.

One of the difficulties of translating Buddhist texts is that there are many soteriological terminologies. Those terms came from Indian languages of different periods and regions including Sanskrit, Prakrit and even the languages of Central Asian. In China, they were translated into Chinese in various periods and regions. Between a liberal and literal translation there has always been discussions, by which the two "new translations" by Kumārajīva (343–413) and Xuanzang (600–664) are the eminent examples. In the texts by Xinxing, a great amount of scriptural texts from different periods are extensively quoted, which make his texts actually stylistic not uniformly, and certain passages or words would be hardly understandable, without the help of the Buddhist dictionaries or lexicons. The translator has mainly referred to the *Great Fo Guang Dictionary*, the online *Digital Dictionary of Buddhism* by Charles Muller as well as *A Dictionary of Chinese Buddhism* by Soothill and Hodous. The translator tried to make the translation of the four texts uniformly and used the fixed translation for the terms as long as they mean the same.

Concerning the Sanskrit terminologies the words in scriptures left in Sanskrit by the translators will not be translated into English. The words such as pāramitā (波罗蜜, perfection), for which no adequate English equivalents exist, have been left in Sanskrit. They are rendered as Sanskrit words with their diacritical marks and the meaning are given in the endnotes, so that the reader can know at once that the original word in Chinese are transliterations. The words like dharma, sutra etc., whose spellings are no longer considered foreign to English, have been anglicized, and the diacritical marks have been removed. The plural of all Sanskrit words has been formed in the English way, by adding an *s*. All Sanskrit words in the text are in italic type for smoother reading. The titles of Buddhist scriptures are also generally translated into plain English, such as the 華嚴經 is translated as the *Flower Garland Sutra* rather than *Avatasaka-sūtra*.

The translation is based on the transcription by Zhang Zong, who has intensively worked on the research of the Jinchuanwan Cave for years. Also, there are a few additions and amendments by the translator in the duration of translating and fieldwork, which are agreed by the transcriber. The translator punctuated the texts according to his own understanding, and the translation is based on the punctuated text. It should be mentioned that there have been vacant places in the original texts where paragraphs or sentences come to the end. Only due to the punctuation in the transcription, they are not apparent anymore. For the passages, which were badly damaged and not understandable, they are not punctuated, but keep the original status.

For the convenience of reading and comparing, the transcription and translation are parallel arranged. On the left is the transcription with the line number; on the right is the English translation. Also concerning the content it is tried to make them parallel as much as possible, though sometimes it is not always ideal since the original format of the transcription is kept. (Of course the original carved texts run actually from above to bottom, from the right to the left.) In order to follow the structure easily, the passages and sentences are numbered by the translator as long as they are clear. The original indications for the structures or for the numbering of the sentence will be not translated. If the contents are parallel, they will then be parallel arranged. Thus the sentences are not arranged in a usual way and the distance between each line of the transcription are enlarged, but the translator believes that such arrangement of the translation is easier for the reader to understand the structure as well as the contents.

**Fig. 6:** Western wall

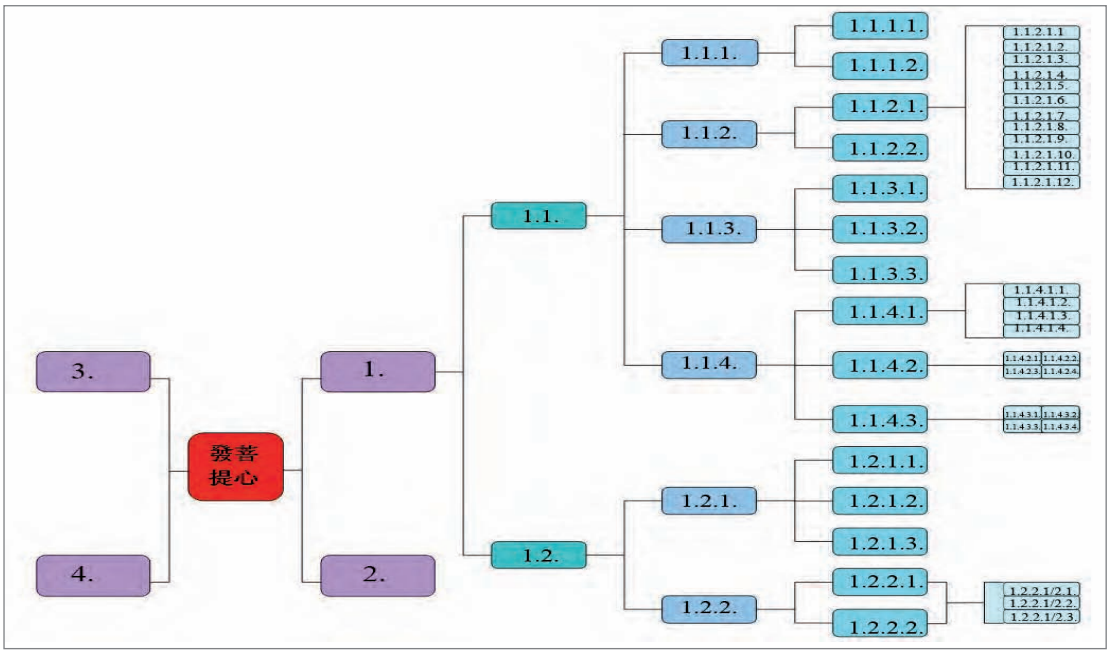


**Fig. 7:** Structure of the text *Clarifying the Methods in the Scriptures about Arousing the Mind to Enlightenment in Accord with One's Depth of Capacity*

The translating of such valuable inscriptions offered me a chance to access the study of the Teaching of the Three Stages, which is a exiting as well as a challenging task. The translation process is slow and arduous since the translator has to check the characters from photos or track down the citations that Xinxing so liberally scattered throughout his writings, in order to understand his thoughts. The translator hopes that he has grasped the gist of Xinxing's texts and can thus transmit them to the reader correctly. Furthermore, he hopes that future authors will be able to improve the translations.

## Endnotes

1 Although the School is mentioned in many histories of Buddhism or discussed in numerous articles by scholars worldwide, the most important studies on the history of the School are made by Japanese scholars. Among them, the two monographs with the same title by Yabuki Keiki (1879–1939) and Nishimoto Teruma (*1962) are monumental. Yabuki Keiki, *Sankaikyō no kenkyō*. Tokyo: Iwanami shoten, 1927. Nishimoto Teruma, *Sankaikyō no kenkyō*. Tokyo: Shunjūsha, 1998. In the western world the monograph written by Jamie Hubbard is the single one on the subject. Jamie Hubbard, *Absolute Delusion, Perfect Buddhahood: The Rise and Fall of a Chinese Heresy*. Nanzan Library of Asian Religion and Culture. Honolulu: University of Hawai'i Press, 2001.

2 For the archaeological study of the cave and the carved texts, see Zhang, Zong and Wang, Baoping, "Shaanxi chunhua jinchuanwan sanjiejiao kejing shiku" (A Grotto with San Jie Buddhist Inscriptions at Jinchuanwan, Chunhua, Shaanxi) in *Wenwu*, No. 5, 2003.

3 See Ibid., p. 66.

4 See Ibid., p. 71–72.

5 The manuscript from Dunhuang (P.2283) is now reserved in Paris: Bibliotheque Nationale and it was published in 1970. See Jacques Gernet et Wu Chi-yu, et al., Catalogue des manuscrits chinois de Touen-Houang (Fonds Pelliot chinois), vol. 1, nos. 2001–2500. Paris: Bibliothèque Nationale, 1970.

6 T12, no. 374, p. 412c.

7 The ritual text by Xinxing, *Zhouye liushi fayuanwen*, was included in the compilation by Zhisheng (7th to 8th century), *Ji zhujing lichanyi*, which is however longer than the one on the stone. See T47, no. 1982, p. 465.

8 See Li Yu-min, "Baoshan dazhushengku chutan." *National palace museum quarterly*, vol. 16 (No. 2, 1998).

# The Four Texts Compiled by Meditation Master Xinxing (540–593) Carved in Jinchuanwan Cave, Shaanxi, China

**Translated by Zhao, Zhou**

**Based on the transcriptions of Zhang, Zong**

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0 明諸經中對根淺深發菩提心法一卷 信行禪師撰

Clarifying the Methods in the Scriptures about Arousing the Mind to Enlightenment in Accord with One's Depth of Capacity, One Scroll. Compiled by Meditation Master Xinxing

1 於中有四段明義：一者明發菩提心寬狹長短法；二者明發菩提心寬狹因淺深法；三者明發菩提心

Therein are four sections clarifying the significance:
1. Clarifying the methods of arousing the mind to enlightenment in regards to the wide, narrow, long and short [dimensions];
2. Clarifying the methods of arousing the mind to enlightenment in regards to the depth of one's wide and narrow cause;
3. Clarifying the methods of arousing the mind to enlightenment in regards to the depth of one's basic capacity to receive [the teachings];
4. Clarifying the methods of arousing the mind to enlightenment in regards to the depth of one's practices which arise in accord with the capacity.

2 能受根機淺深法；四者明發菩提心對根起行淺深法。 第一大段明發菩提心寬狹長短法者，於

1. The first main section is the clarification of methods of arousing the mind to enlightenment in regards to the wide, narrow, long and short [dimensions], wherein are mainly two parts:
1.1. The exhaustion of objects of perception;
1.2. The perfection of practices.

3 中大判有兩段：一者境盡；二者行周。 第一段境盡者，於中大判有四段：一者明一切佛盡；二者明

1.1. The first part is the exhaustion of objects of perception, wherein are mainly four parts:
1.1.1. Clarifying all Buddhas[1] exhaustively;
1.1.2. Clarifying all Dharmas exhaustively;
1.1.3. Clarifying all Sanghas exhaustively;
1.1.4. Clarifying all sentient beings exhaustively.

4 一切法盡；三者明一切僧盡；四者明一切衆生盡。 第二段行周者，於中大判有兩段：一者明離一

1.2. The second part is the perfection of practices, wherein are mainly four parts:
1.2.1. Clarifying severing all evils exhaustively;
1.2.2. Clarifying cultivating all goods exhaustively.

5 切惡盡；二者明修一切善盡。 第一明一切佛盡者，於中大判有兩段：一者明真身佛，二者明應身

1.1.1. The first is the clarification of all Buddhas exhaustively, wherein are mainly two parts:
1.1.1.1. Clarifying the True-Body[2] Buddhas;
1.1.1.2. Clarifying the Response-Body Buddhas.

6 佛。第一真身佛者；由上同諸佛成；第二應身佛者；由下同衆生成。法僧等義通二處：與真相應屬真，

The first are the True-Body Buddhas, who accomplished [Buddhahood] with the Buddhas from above; the second are the Response-Body

7 與應相應屬應。 第二明一切法盡者，於中大判有兩段：一者明大乘十二部經；二者明小乘十二

8 部經。 第一大乘十二部經者，一者梵音名修多羅經，漢語名爲本經；二者梵音名爲祇耶經，漢語

9 名爲重誦經，或名不等偈；三者梵音名爲和伽羅那經，漢語名爲受記經；四者梵音名爲伽陀經，漢

10 語名爲等偈經，亦名不通上偈；五者梵音名憂陁那經，漢語名爲無問自說經；六者梵音名爲尼陁

11 那經，漢語名爲因緣經；七者梵音名爲阿波陁那經，漢語名爲譬喻經；八者梵音名爲伊帝曰多伽

12 經，漢語名爲本事經；九者梵音名爲闍多伽經，漢語名爲本生經；十者梵音名爲毗佛略經，漢語名

Buddhas, who accomplished [Buddhahood] with the sentient beings from below. The significance regarding the Dharmas and Sanghas is parallel with the two situations: those corresponding to the True[-Body Buddhas] belong to the True[-Body Buddhas], and those corresponding to the Response[-Body Buddhas] belong to the Response[-Body Buddhas].

1.1.2. The second is the clarification of all Dharmas exhaustively, wherein are mainly two parts:
1.1.2.1. Clarifying the Twelve Divisions of the Canon of the Great Vehicle;
1.1.2.2. Clarifying the Twelve Divisions of the Canon of the Small Vehicle.

1.1.2.1. The first is the Twelve Divisions of the Canon of the Great Vehicle:
1.1.2.1.1. [The first division] is called *sūtra* in Sanskrit, and in Chinese it is called „Original Scripture“;
1.1.2.1.2. [The second division] is called *geya* in Sanskrit, and in Chinese it is called „ Scripture of Repeated Verses “, or called “Unequal-lengthened Verses“;
1.1.2.1.3. [The third division] is called *vyākara□a* in Sanskrit, and in Chinese it is called „Scripture of Bestowed Predictions“;
1.1.2.1.4. [The fourth division] is called *gāthā* in Sanskrit, and in Chinese it is called „Scripture of Equal-lengthened Verses“, also called “Verses of Non-iteration”;
1.1.2.1.5. [The fifth division] is called *udāna* in Sanskrit, and in Chinese it is called „Scripture of Self-expounding without Asking“;
1.1.2.1.6. [The sixth division] is called *nidāna* in Sanskrit, and in Chinese it is called „Scripture of Causes and Conditions“;
1.1.2.1.7. [The seventh division] is called *avadāna* in Sanskrit, and in Chinese it is called „Scripture of Parables“;
1.1.2.1.8. [The eighth division] is called *itiv□ttaka* in Sanskrit, and in Chinese it is called „Scripture of the Past Lives of Buddha’s Disciples“;
1.1.2.1.9. [The ninth division] is called *jātaka* in Sanskrit, and in Chinese it is called „Scripture of the Past Lives of Buddha“;
1.1.2.1.10. [The tenth division] is called *vaipulya* in Sanskrit, and in Chinese it is called „Scripture of the Correctness and Extensiveness“;
1.1.2.1.11. [The eleventh division] is called *abdhūta-dharma* in Sanskrit,

13 爲方廣經；十一者梵音名爲阿浮達磨經，漢語名爲希有或未曾有經；十二者梵音名爲優波提舍

and in Chinese it is called „[Scripture of] the Rare" or „Scripture of the Unprecedented";
1.1.2.1.12. [The twelfth division] is called *upadeśa* in Sanskrit, and in Chinese it is called „Scripture of Discussing the Significance".

14 經，漢語名爲論義經。 第二小乘十二部經者，□□□名□□我□□□□□□□□□□□□。第

1.1.2.2. The second is the Twelve Divisions of the Canon of the Small Vehicle:
□□□ called □□ my □□□□□□□□□□□□□□□

15 三明一切僧盡者，於中大判有三段：一者凡夫僧，二者聲聞僧，三者菩薩僧。 第四明一切衆生盡

1.1.3. The third is the clarification of all Sanghas exhaustively, wherein are mainly three parts:
1.1.3.1. Worldling monks[3];
1.1.3.2. [Voice-hearer monks;]
1.1.3.3. [Bodhisattva monks.]

16 者，於中大判有三段：一者明一切諸佛菩薩所度衆生人淺深盡；二者明一切諸佛菩薩所度衆生

1.1.4. The fourth is the clarification of all sentient beings exhaustively, wherein are mainly three parts:
1.1.4.1. Clarifying the depth of the kinds[4] of sentient beings saved by all Buddhas and bodhisattvas exhaustively;
1.1.4.2. Clarifying the depth of the basic capacities of sentient beings saved by all Buddhas and bodhisattvas exhaustively;
1.1.4.3. Clarifying the depth of the practices of sentient beings saved by all Buddhas and bodhisattvas exhaustively.

17 根機淺深盡；三者明一切諸佛菩薩所度衆生行淺深盡。第一明一切諸佛菩薩所度衆生人淺深

1.1.4.1. The first is the clarification of the depth of the kinds of sentient beings saved by all Buddhas and bodhisattvas exhaustively, wherein are four stages as expounded in the *Vimalakīrti Sūtra*:
1.1.4.1.1. Saving the worldlings with correct views, as expounded in the "Chapter on Expedient Means";
1.1.4.1.2. Saving [those of] the Two Vehicles[5], as expounded in the "Chapter on Disciples";
1.1.4.1.3. Saving the bodhisattvas, as expounded in the "Chapter on Bodhisattvas";
1.1.4.1.4. Saving all devils and the heretics, as expounded in the "Chapter on Mañjūśrī Inquiring after the Illness".[6]

18 盡者，於中有四階，如《維摩經》說：一者度正見凡夫，如《方便品》說；二者度二乘，如《弟子品》說；三者度菩

19 薩，如《菩薩品》說；四者度一切衆魔及諸外道，如《文殊師利問疾品》說。第二明一切諸佛菩薩所度衆

1.1.4.2. The second is the clarification of the depth of the basic capacity of sentient beings saved by all Buddhas and bodhisattvas exhaustively, wherein are four stages, as the Four Vehicles[7] expounded in the *Śrīmālā Sūtra*.

20 生根機淺深盡者，於中有四階，如《勝鬘經》中說四乘是。第三明一切諸佛菩薩所度衆生行淺深盡

1.1.4.3. The third is the clarification of the depth of the practice of sentient beings saved by all Buddhas and bodhisattvas exhaustively, wherein are also four stages, as the “those who practise together”, “those who rejoice in the welfare of others”, “those who see”, “those who listen” etc.,[8] expounded in the “Chapter on Bodhisattva Sage Head” of the *Flower Garland Sūtra*,

21 者，於中亦有四階，如《華嚴經賢首菩薩品》中說同行、隨喜、見、聞等是。 第五離一切惡盡者，於中大

1.1.5.[9] The fifth is the clarification of severing all evils exhaustively, wherein are mainly three parts:
1.1.5.1. Severing the hindrances of afflictions;
1.1.5.2. Severing the hindrances of actions;
1.1.5.3. Severing the hindrances of retributions.

22 判有三段：一者離煩惱障，二者離業障，三者離報障。 第六修一切善盡者，於中大判有兩段：一者

1.1.6. The sixth is the clarification of practicing all goods exhaustively, wherein are mainly two parts:
1.1.6.1. The sublime of meritorious virtues;
1.1.6.2. The sublime of wisdom.

23 福德莊嚴；二者智慧莊嚴。又福德智慧二種莊嚴，於中有三階：一者從一地乃至十地，是名慧莊嚴；

Further the two kinds of sublimes of meritorious virtues and wisdom, therein are three stages:
Firstly from the first level even to the tenth level[10] they are called the sublime of wisdom[11]; the sublime of meritorious virtues are [from] dāna-pāramitā even to prajñā- and non prajñā-pāramitā[12];

24 福德莊嚴者，謂檀波羅密乃至般若非般若波羅蜜；二者慧莊嚴者，所謂諸佛菩薩；福德莊嚴者，謂

Secondly the sublime of wisdom, namely the Buddhas and bodhisattvas; the sublime of meritorious virtues are voice-hearers, solitary realizers and nine-abiding bodhisattvas.

25 聲聞緣覺九住菩薩；三者福德莊嚴者，有爲、有漏、有、有果報、有礙、非常，是凡夫法；慧莊嚴者，無爲、無

Thirdly the sublime of meritorious virtues, conditioned, contaminated, existent[13], with retribution, with obstruction, impermanent, are the dharma of worldlings; the sublime of wisdom, unconditioned, uncontaminated, non-existent[14], without retribution, without obstruction, eternally abiding, as expounded in the “Chapter of Lion’s Roar” in the 27th scroll of the *Nirvā□a Sūtra*.

26 漏、無有、無果報、無礙、常住，如《涅槃經第二十七卷師子吼品》中說。 第二大段明發菩提心寬狹因

2. The second section is the clarification of methods of arousing the mind to enlightenment in regards to the depth of one’s wide and narrow cause, [wherein] are six [parts:]

27 淺深法者，於中有六段： 第一明一切佛盡者，上明寬狹長短盡，此明見佛因淺深義。於中有六

2.1. [The first] is the clarification of all Buddhas exhaustively. The

階：

28 一者意業。如《華嚴經賢首品》說，念佛三昧必見佛，命終之後生佛前。 如《無量壽佛經》廣說，即於經

29 中敬人觀行時，即唯□□時□□□事□□□□若有善男子善女人及餘一切衆生，得聞是五十

30 三佛名者，是人於百千萬億阿僧祇劫不墮惡道。三者口业。若複有人能称是五十三佛名者，生生

31 之處常得值遇十方諸佛。四者身業。若複有人能至心敬禮五十三佛者，除滅四重、五逆、謗方等

32 悉皆得清淨。以是諸佛本誓願故，於念念中即得除滅如上諸罪。即於經中教，還禮諸佛。晝夜六時

33 心想明利，猶如流水行懺悔法。然後繫念，念藥王藥上二菩薩清淨色身。如《觀藥王藥上二菩薩經》

34 中说。□□□人行道，一切□行道。見有諸佛羅列在前，一一諸佛手摩我頂聽我悔過。 如《大方等經》

above clarifies the wide, narrow, long and short [dimensions] exhaustively, here it clarifies the significance of the depth of one's cause to see the Buddha, wherein are six stages:

2.1.1. Intentional Actions. As expounded in the "Chapter on Bodhisattva Sage Head" of the *Flower Garland Sūtra,* "Any who enters into the absorption of mindfulness of the Buddha must see the Buddha, and after the end of the life be reborn in front of the Buddha." [15] [As] extensively expounded in the *Sūtra of the Buddha of Inmeasurable Life*, just as [instructed] in the sūtra while revering people and practising contemplation, just only □□while □□□ things □□□□. "If good men and good women as well as all other sentient beings have heard the names of these fifty-three Buddhas, they shall never fall in the evil path in hundreds of millions of Asa□khyeya[16] eons."[17]

2.1.3. [Oral Actions.][18] "If further one can praise the names of these fifty-three Buddhas, in the places of birth and rebirth one shall eternally meet the Buddhas of the ten directions."[19]

2.1.4. Bodily Actions. "If further one can sincerely and mindfully revere and worship the fifty-three Buddhas, the Four Grave Crimes, the Five Heinous Crimes[20], and [the crimes of] Slandering the Buddhism[21] will be removed and destroyed, and all [the crimes] will be cleared and purified. Because of the original vows of the Buddhas, by the constantly thinking [on the Buddhas' names] the above crimes will be removed and destroyed at once. Just as instructed in the sūtra, [one should] still worship the Buddhas. In the six times of day and night one keeps mind and thought clear and keen, and [continuously] like the flow of water one practises the ritual of confession and repentance. After that one fixes one's mind on thinking on the clean and pure material bodies of the two bodhisattvas Medicine King and Medicine Sublime"[22], as expounded in *Sūtra of Visualizing the Two Bodhisattvas Medicine King and Medicine Sublime.* [23]

[2.1.5.] □□□ persons practising the Way, all □ practising the Way. "[I] saw the Buddhas in a row before me, who rubbed the top of my head with their hands one by one, listened to my repentance of transgressions"[24], as [expounded] in the *Great Universal Equality Sūtra*[25] □□ knowing the Buddha.

35 □□知佛。 六者明常不輕比丘□□□□。故是比丘臨欲終時於虛空中具聞威音王佛先所說

36 《法華經》二十千萬億偈。悉能受持□□得是六根清淨。更增壽命二百萬億那由他歲，命終之後得

37 值二千億佛。即於經中□□□□□而是比丘不專讀誦經典，但行禮拜 如《法華經第六卷不輕

38 菩薩品》說。 第二明一切法盡者，上明寬狹長短盡，此明聞法因淺深義。於此有三階：一者一聞《涅槃

39 經》賣身供養佛，唯能受持一偈： 如來證涅槃 永斷於生死 若能至心聽 常得無量樂。受

40 是偈已即便還至彼病人家。善男子，我時雖複日日與三兩肉，以念偈因緣故不以爲痛。日日不廢

41 足滿一月。如《涅槃經第二十二卷》中說。 二者明童子聞偈捨身所如《涅槃經第十四卷》中說。所得

42 偈者： 諸行無常 是生滅法 生滅滅已 寂滅爲樂。 三者如《華嚴經十地品第三明地》中廣

2.1.6. Clarifying the *bhik□u* Never Despise □□□□. "Therefore the *bhik□u* just before the end of his life heard fully the twenty thousands trillion verses of the *Lotus Sūtra* from space, which were once expounded by the Buddha Majestic Voice King. All [of them] were received and upheld." □□ "[After] his six sense organs[26] clarified and purified, his lifespan was furthermore expanded with two hundred trillion nayuta[27] years, and after the end of his life he will meet two hundred billion Buddhas."[28] Just as [instructed] in the sūtra □□□□□ "but the *bhik□u* did not exclusively read and recite scriptures, but also practised worship and respect"[29], as expounded in the 6th scroll "Chapter on Bodhisattva Never Despise" of the *Lotus Sūtra*.

2.2. The second is the clarification of all Dharmas exhaustively. The above clarifies the wide, narrow, long and short [dimensions] exhaustively, here it clarifies the significance of the depth of one's cause to hear the Teachings, wherein here are three stages:

2.2.1. Once hearing that in the *Nirvā□a Sūtra* [there was one who] sold his body for the sake of offering and sustaining the Buddha, just in order to be able to receive and uphold one verse. "The Tathāgata realized the Nirvā□a, and forever he severed himself from life and death; if one hears it sincerely and mindfully, he will permanently obtain the infinite happiness. After receiving the verse I went then immediately back to the home of the sick. Good sons, though at that time I always gave [the sick] three ounces my own flesh day after day, because of the causes and conditions of thinking on the verse I did not feel the pain, thus day after day without a stop for a full month." [30] As expounded in the 22nd scroll of the *Nirvā□a Sūtra*.

2.2.2. Clarifying the boy sacrificing himself for the sake of hearing one verse as expounded in the 14th scroll of the *Nirvā□a Sūtra.* The obtained verse reads: "That all things are impermanent, is the rule of life and death; After the cessation of life and death, the peaceful stillness becomes the happiness." [31]

2.2.3. As extensively expounded in the "3rd Part Stage of Illumination" of the "Chapter on Ten Stages" of the *Flower Garland Sūtra*. □□□□□ "because the bodhisattva sought the Teachings through the expedient

43 說。□□□□□菩薩如是方便求佛法故，無有諸財錢穀倉庫寶藏等事而不能舍。於此物中不生

44 難想，但於說法者生難遭想。是菩薩爲求佛法故，無有所用外財而不能舍，無有內財而不能舍，無

45 有所作供給尊事而不能行，無有勝慢我慢大慢等而不能舍。質直柔軟故，無有身苦而不能受。是

46 菩薩得成就勝財心，若聞一句未曾聞法，勝得滿三千大千世界珍寶。是菩薩得聞一偈正法生上

47 財想，勝得轉輪聖王位。複得勝財心，若得未曾聞法，能淨菩薩行，勝得釋提恒因梵天王處無量劫

48 住。是菩薩若有人來，作如是言：我與汝佛所說法一句，能淨菩薩行。汝今若能入大熾然火坑受大

49 苦者，當以相與。 是菩薩作如是念：我受一句佛所說法能淨菩薩行故，尚於三千大千世界滿中大

50 火從梵天投下。何況入小火坑？我等法應盡受一切諸地獄苦，猶應求法。何況人中諸小苦惱？菩薩

means such as those, he had no wealth and money, granaries and treasure deposits etc. which could not be abandoned. From those things he did not produce the thought of difficulty, but from a teacher of the Teachings he produced the thought of difficulty to meet. Because the bodhisattva was to seek the Teachings, he had no useful exterior wealth which could not be abandoned, no interior wealth which could not be abandoned, no practical things of offering, giving and revering [the Buddha] which he could not practise. He had no pride in surpassing others, no self-pride and no great pride etc. which could not be abandoned. Because [his character] was upright and straight, tender and mild[32], he had no bodily sufferings which could not be endured. The bodhisattva achieved the mind of overcoming wealth, and if he heard a sentence of the Teachings which he had never heard before, [to him] it was better than obtaining the jewels and treasures which could fulfil the three thousand great chiliocosms[33]. The bodhisattva heard one verse of the True Teachings and produced the thoughts of transcending wealth; [to him] it was better than obtaining the throne of a Wheel Turning Sage King. Further he obtained the mind of overcoming wealth, and if he heard the Teachings which he had never heard, which could clean the practices of bodhisattva, [to him] it was better than obtaining the abidance for infinite eons in the place of Great Brahman Heaven Śakrodevānām Indrah. If someone came to the bodhisattva and said the following: ‘I give you a sentence of the Teachings expounded by the Buddha, which could purify the practices of the bodhisattva. If you now can enter a large flaming fire pit and endure the great suffering, I shall give it to you.’ The bodhisattva thought like this: ‘Because I receive a sentence of the Teachings expounded by the Buddha, which can purify the practices of bodhisattva, I even threw myself down to the large fire that fully filled the three thousand great chiliocosms from the Brahman Heaven, how much less it is to enter a small fire pit! In accordance with the Teachings we should endure the sufferings of all hells exhaustively and still we should seek the Teachings, how much less it is the small sufferings in the [realm of] human being!’ In this way the bodhisattva aroused his vigor and practiced the True Teachings; following the Teachings he had heard, he was able to practice correct contemplation in every pure and tranquil place.”[34]

2.3. The third is the clarifications of all Sanghas exhaustively. The above clarifies the wide, narrow, long and short [dimensions] exhaustively;

51 如是發精進行，修諸正法，隨所聞法於寂靜處悉能正觀。第三明一切僧盡者，上明寬狹長短盡，

52 此明歸僧因淺深義，於中總證於一切衆僧。莫問行住坐臥，三業起作皆須體順不違，種種恭敬種

53 種供養，如一切大小乘修多羅中具足廣說，處處皆言上妙樂水供養衆僧。 第四明一切衆生盡

54 者，上明寬狹長短盡，此明度脫衆生因淺深義。於中有三段：一者作是念：我當悉令一切衆生得無

55 上智王。安隱住處不爲自度，但欲令彼出生死淵，得一切智心，拔出衆生惡道峻穀，救無量苦度生

56 死流。二者複作是念：我當爲一切衆生受無量苦，令諸衆生悉得免出生死沃焦。我當爲一切衆生

57 於一切剎一切地獄中受一切苦，終不舍離。我當於一一惡道盡未來劫代諸衆生受無量苦。何以

58 故？我寧獨受諸苦，不令衆生受諸楚毒。當以我身免贖一切惡道衆生令得解脫。三者唯我一人，志

here it clarifies the significance of the depth of one's cause to take refuge in the Sanghas，wherein it is generally realized to all Sanghas. No matter walking, standing, sitting or lying down, the arising and working of their Three Actions should be all in accord with the Essence properly, with various kinds of reverence and respect, various kinds of offering and sustaining, as completely extensively expounded in all *sūtras* of Great and Small Vehicles, wherein throughout is said to offer and sustain all Sanghas with the superb wonderful joyful water.

2.4. The fourth is the clarification of all sentient beings exhaustively. The above clarifies the wide, narrow, long and short [dimensions] exhaustively; here it clarifies the significance of the depth of one's cause to save the sentient beings, wherein are three parts:

2.4.1. Thinking like this: "I should entirely make all sentient beings to obtain the [result of] King of Unsurpassed Wisdom. In the calm concealed abiding place [I am] not for the sake of saving myself, but intended to cause them to be out of the abyss of life and death, to obtain the mind of all wisdom, and pull all sentient beings out the evil paths and dangerous valleys, and rescue the infinite sufferings and save [them from] the stream of life and death."[35]

2.4.2. Further thinking like this: "I should undergo the immeasurable sufferings on behalf of all sentient beings, cause all sentient beings entirely be exempted from the Pātāla[36] of life and death. I should undergo all the immeasurable sufferings on behalf of all sentient beings in all realms and in all hells, without giving up in the end. I should undergo the immeasurable sufferings on behalf of all sentient beings in each evil path to the utmost in the future eon. Why? I would rather alone undergo the sufferings than let the sentient beings undergo the torments and cruelties. I should use my body to redeem the sentient beings from all the evil paths and cause them be liberated."[37]

2.4.3. "Only I single person with solitary will and unaccompanied, cultivate the good capacities and transfer them back. I am resolved to save all sentient beings, to illuminate universally all sentient beings, to distinguish all sentient beings, to enlighten all sentient beings, to bring all sentient beings into the very profound Teachings, to win over all sentient beings, to accomplish all sentient beings, to delight all sentient

59 獨無侶，修諸善根回向。欲爲度脫一切衆生，普照一切衆生，分別一切衆生，了達一切衆生，令一切

60 衆生入甚深法，攝取一切衆生，成就一切衆生，悅樂一切衆生，柔軟一切衆生，滅除一切衆生疑或。

61 如《華嚴經十回向品第一救護衆生回向》說。第五明離一切惡盡者，上明寬狹長短盡，此明離惡

62 因淺深義。□□於中有三段：一者身業。一願從今身乃至成佛願不煞生；二願從今身乃至成佛願

63 不偷盜；三願從今身乃至成佛無有婬欲。二者口業。一願從今身乃至成佛願不妄語；二願從今身

64 乃至成佛願不惡口；三願從今身乃至成佛願不兩舌；四願從今身乃至成佛願不綺語。三者意業。

65 一願從今身乃至成佛願不貪；二願從今身乃至成佛願不嗔；三願從今身乃至成佛願不癡。此十

beings, to soften [the hearts of] all sentient beings, to eliminate the doubts and perplexities of all sentient beings", as expounded in the "First Part Saving and Protecting the Sentient Beings and Transferring them Back" in the "Chapter on Ten Transferring Back" of the *Flower Garland Sūtra*.[38]

2.5. The fifth is the clarification of severing all evils exhaustively. The above clarifies the wide, narrow, long and short [dimensions] exhaustively; here it clarifies the significance of the depth of the cause to sever evils, □□ wherein are three parts:

2.5.1. Bodily Actions
2.5.1.1. Vowing from the present body until accomplishing Buddhahood never to kill lives.
2.5.1.2. Vowing from the present body until accomplishing Buddhahood never to steal.
2.5.1.3. Vowing from the present body until accomplishing Buddhahood never to have sexual desire.

2.5.2. Oral Actions
2.5.2.1. Vowing from the present body until accomplishing the Buddhahood never to speak false speech.
2.5.2.2. Vowing from the present body until accomplishing the Buddhahood never to speak harsh speech.
2.5.2.3. Vowing from the present body until accomplishing the Buddhahood never to equivocate.
2.5.2.4. Vowing from the present body until accomplishing the Buddhahood never to speak ornate speech.

2.5.3. Intentional Actions
2.5.3.1. Vowing from the present body until accomplishing Buddhahood never to covet.
2.5.3.2. Vowing from the present body until accomplishing Buddhahood never to anger.
2.5.3.3. Vowing from the present body until accomplishing Buddhahood never to be ignorant.
Those ten teachings are just in the dharma realm doing □□□□□ therefore no matter Great Vehicle or Small Vehicle all □□□□ expounded, thence knowing [them] the utmost fundament of all evils.

66 法正是法界作□□□□□故莫問大乘小乘一切□□□□說者，所以得知最是衆惡根本。 第

67 六明修一切善盡者，上明寬狹長短盡，此明法界□□□本淺深義。於中有四段：一者六波羅蜜；二

68 者四攝；三者四無量；四者四辯。如是四行是一切□身行根本。何以故？見一切大乘經中處處

69 皆說□□如是。 第三大段明發菩提心能受根機淺深法者，於中有七段：一者明三業具足，如《華

70 嚴經淨行品》說；二者明□□□□□□□□無□煩惱，如《涅槃經第二卷純陁品》說；三者明種性成

71 □□□□□□□□□□□□□□□；四者明久行六波羅密多，供養諸佛種善根，與善知識相隨，

72 诸佛诸菩萨随喜福德，如《摩诃般若經隨喜品》說；五者明四親近。此一親近善知識，二聽聞正法，

73 三繫念思惟，四如法修行。如《大涅槃經第廿五卷第七功德》所說；六者明能受一乘法人，於中有兩段：

2.6. The sixth is the clarification of cultivating all good exhaustively. The above clarifies the wide, narrow, long and short [dimensions] exhaustively, here it clarifies in the dharma realm □□□ the fundament the depth the significance, wherein are four parts:
2.6.1. Six Pāramitā[39];
2.6.2. Four [Methods of] Winning Over[40];
2.6.3. Four Infinities;
2.6.4. Four Abilities of [unhindered] Understanding and Expression[41];
Such like those[42] the Four Practices are all □ bodily practices fundament. Why? See in all Scriptures of the Great Vehicle throughout all saying □□ like that.

3. The third section is the clarification of the methods of arousing the mind to enlightenment in regards to the depth of one's basic capacity to receive [the Teachings], wherein are seven parts.
3.1. Clarifying the completeness of the Three Actions, as expounded in the "Chapter on Practices of Purity" of the *Flower Garland Sūtra*;
3.2. Clarifying □□□□□□□□ no □ afflictions, as expounded in the "Second scroll Chapter Cunda" of the *Nirvā□a Sūtra*;
3.3. Clarifying the seed nature accomplishing □□□□□□□□□□ □□□□□;
3.4. Clarifying "practising the Six Pāramitā for long time, offering and sustaining the Buddhas and planting the good roots, being accompanied by the Genuine Teachers[43], accordingly rejoicing at the meritorious virtues of the Buddhas and bodhisattvas", as expounded in the "Chapter of Accordingly Rejoice" of the *Mahāprajñā Sūtra*;[44]
3.5 Clarifying the Four Practisings. The first is becoming intimate with the Genuine Teachers, second hearing and comprehending the True Teachings, thirdly fixing the mind on thinking, fourthly cultivating and practising according to the Teachings, as expounded in the "7th part Merit and Virtue" of the 25th scroll of the *Great Nirvā□a Sūtra*.[45]
3.6. Clarifying the persons who can receive the Teachings of the Single Vehicle, wherein are two parts:
[3.6.1.] □□□□□□□□□□□□
3.6.1.1. □□those who come from one Buddha land, receive the dharma-body;
3.6.1.2. Those who come from the path of heavenly [beings];
3.6.1.3. Those who come from the path of human beings;
3.6.1.4. □□□□□□□□□□□□ persons.

74 □□□□□□□□□□□□□□□一方佛土來者，受法身，第二從天道來者，第三從人道來者，第

75 四□□□□□□□□□□□□人。明能受一乘法人，一阿惟越致諸菩薩摩訶薩；二正見成就人；

76 三　　漏盡阿羅漢。□□多見佛於諸佛所多供養種善根。親近善知識有利根，如《大般若經幻人聽法品》

77 說； 七者具明能使得□□。若有利根 智慧明瞭 多聞強識 求佛道者 如是之人 乃可爲說 若人曾見

78 億百千佛 殖諸善本 深心堅固 如是之人 乃可爲說 若人精進 常修慈心 不惜身命 乃可爲說 若人

79 恭敬 無有異心 離諸凡愚 獨處山澤 如是之人 乃可爲說 又舍利弗 若見有人 舍惡知識 親近善友

80 如是之人 乃可爲說 若見佛子 持戒清淨 如淨明珠 求大乘經 如是之人 乃可爲說 若人無嗔 質直

81 柔軟 常濬一切 恭敬諸佛 如是之人 乃可爲說 複有佛子 於大衆中 以清淨心 種種因緣 譬喻言辭

82 說法無礙 如是之人 乃可爲說 若有比丘 爲一切智 四方求法 合掌頂受 但樂受持 大乘經典 乃至

[3.6.2.] Clarifying the people who can receive the Teachings of the Single Vehicle:
3.6.2.1. Avaivartika[46] bodhisattva mahāsattva;
3.6.2.2. Those who have accomplished the correct view;
3.6.2.3. Arhats without contamination.
"□□ more seeing the Buddha in the places of the Buddhas [making] more offerings and sustainings and planting good roots, becoming intimate with the Genuine Teachers and having sharp capacities"[47], as expounded in the "Chapter on Illusionist Hearing the Teachings" of the *Great Prajñā Sūtra*.
3.7. Clarifying completely can make to obtain □□.
"If there any who has sharp capabilities, of clear wisdom, learned and of strong memory, who seek after the Buddha Way, to such people as this, then you may expound it; If any has ever seen, thousands of millions of Buddhas, cultivated many good origins, and been firm in their inmost minds, to such people as this, then you may expound it;
If any has zealously progressed, constantly cultivated kindly minds, and never spared body and life, then you may expound it to them;
If any has been reverent, with unvarying mind, left all the ignorant, and dwelt alone in mountains and swamps, to such people as this, then you may expound it; Again Śāriputra! If you see any, who gives up bad friends, and become intimate with the good friends, to such people as this, then you may expound it; If you see Buddha Son, who keeps the precepts in purity, like pure bright jewels, who seeks the Scriptures of the Great Vehicle, to such people as this, then you may expound it; If any is free from anger, upright and straight, tender and mild,, always compassionate to all beings, and reverent to the Buddhas, to such people as this, then you may expound it; Further, if there be Buddha Son, who in the general assembly, with pure mind, by various causes and conditions, parables, and expressions, expounds the teachings without any hindrance, to such people as this, then you may expound it; If there is a *bhik□u*, who for the sake of all knowledge, seeks the Teachings in every direction, folds his hands and receives respectfully, is only pleased to receive and keep, the Scriptures of the Great Vehicle, even without accepting, a single verse of any other scriptures, to such people as this, then you may expound it; Like a man who with all his mind, seeks for the Buddhas relics, so if any who seeks the sūtra in a same manner, after having obtained it receives it with great respect, and who is not again, bent on seeking other scriptures, and also has never minded, books and

83 不受 餘經一偈 如是之人 乃可爲說 如人至心 求佛舍利 如是求經 得已頂受 其人不復 志求餘經

84 亦未曾念 外道典籍 如是之人 乃可爲說 告舍利弗 我說是相 求佛道者 窮劫不盡 如是等人 則能

85 信解 汝當爲說 妙法華經 如《法華經第二卷火宅品》中說。第四大段明发菩提心对根起行淺

86 深法者，於中略說九門：一者明下根菩薩敬法師法；二者明下根菩薩所知善真多少；三者明下

87 根菩薩所依善知識法；四者明下根菩薩菩提種子法；五者明下根菩薩所受戒及戒法空；六

88 者明下根从菩薩行法；七者明下根菩薩說法法；八者明下根菩薩敬三寶法；九者明下根菩薩苦

89 行淺深分齊。□□□但作淺深相對說者，皆是爲明上下淺深義。何以故？或就時相異於此□□

records of the heretics, to such people as this, then you may expound it; I say to you, Śāriputra! The situations which I have spoken, the seekers after the Buddha Way, in a whole eon I could not finish, such people as these, are able to believe and discern, you should expound to them, the *Sūtra of the Wonderful Law Lotus*. As expounded in the "Chapter of Firing House" in the 2nd scroll the *Lotus Sūtra*.[48]

4. The fourth section is the clarification of the methods of arousing the mind to enlightenment in regards to the depth of one's practice which arises in accord with the capacity, wherein nine aspects will be briefly expounded.

4.1. Clarifying the method of venerating the dharma teacher for bodhisattvas of inferior capacity;
4.2. Clarifying the amount of knowing the good truth for bodhisattvas of inferior capacity;
4.3. Clarifying the method of relying on the Genuine Teachers for bodhisattvas of inferior capacity;
4.4. Clarifying the method of Bodhi[49] Seeds for bodhisattvas of inferior capacity;
4.5. Clarifying the receiving precepts and the emptiness of the precepts for bodhisattvas of inferior capacity;
4.6. Clarifying the method of following the practices of bodhisattva for [bodhisattvas of] inferior capacity;
4.7. Clarifying the method of expounding the Teachings for bodhisattvas of inferior capacity;
4.8. Clarifying the method of venerating the Three Treasures for bodhisattvas of inferior capacity;
4.9. Clarifying the depth and difference of ascetic practices for bodhisattvas of inferior capacity.

[4.1.] □□□ only those which are expounded by means of the comparatively shallow and deep, are all to clarify the significance of the superior and inferior, shallow and deep. Why? If concerning the time it differs from this □□□□□□□□□□ world evil, clarifying after the Nirvā□a the Buddhas accomplishing the world, clarifying that the superior and inferior pure land is superior, and the dirty land is inferior □□□□□□□□□□□□□□□□□□ those which are expounded together with the worldlings and those of the Two Vehicles in one place are inferior. If

90 □□□□□□□□世惡，明諸佛滅後成就世界，明上下淨土爲上，穢土爲下□□□□□□□

91 □□□□□□□□□□與凡夫二乘一處共說者爲下。或就世間出世間□□□□□□□□

92 □□□□□□□□□□□□爲□爲下。或就多少明上下□□□□□□□□□□□□

93 就□□□□□□□□□□□□菩薩□□□□師□□□□□□□□□□□□□□□□

94 好時□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

95 所爲□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

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97 □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

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100 □□□□□□□□□□□□□□□□□□□□□□□□□□□□□人爲聲聞弟子說，若如是

101 □□□□□□□□□□□□□□□□□□□□□□□□□□□□齋法者。何以故？初明人四依

102 □□□□□□依烦恼□□□□□□□□□□□□□□□能□□以是上法四依義□□與經

103 一切別四依聲所以知是□□□□□□□□□□□□□□諸衆生得說。是四依終不救於有慧

104 眼者，是故得知爲下根菩薩說。□□□□□一者依法不依人。依法者，即是如來大般涅槃一切佛

concerning the mundane and transmundane □□□□□□□□□□□□□□□□□□□□□ is □is inferior, If concerning the amount clarifying the superior and inferior □□□□□□□□□□□□concerning □□□□□□□□ □□□□ bodhisattva □□□□ teacher □□□□□□□□□□□□□□□□ □ □ good time □□□□□□□□□□□□□□□□□□□□□□□□ □ □□□□□□□□□□□□□what is done □□□□□□□□□ □□ □□ □□□□□□□□□□□□□□□□□□□□□□□□□□ □□□ □□□□□□□□□□□□□□□□□□□ body keeping the precepts □□□□□□□□□□□□□□□□□□□□

105 法。如上所說，四人出世護持法者，應當證知而爲依止。□□□是不依人者即是聲聞；二者依義不

106 依語。依義者，即是三寶常住不變。不應依者，所謂諸論綺飾文辭；三者依智不依識。依智者，所言智

107 者即是如來。不依識者，若有聲聞不能善知如來功德，是故知識不應依止；四者依了義經不依不

108 了義經。依了義經不依不了義經，修聲聞乘名不了義，无上大乘乃名了義，如《涅槃經第六卷如來

109 性品》說。 明依經引義非次第抄盡。第三明下根菩薩所依善知識者，於中有兩階：第一諸佛菩薩與

110 二乘凡夫一處說者，上與下同，名爲下善知識；第二唯諸佛菩薩一處說者，名爲上善知識。何以故？

111 第一段善知識中，唯明順而不明其違，所以是下；第二段中，違順具說，所以是上。 第一下根菩薩

112 善知識者，於中有四種：一者親近善友；二者專心聽法；三者繫念思惟；四者如法修行。 第一親近

Cultivating the Vehicle of Voice-hearer is called the unrevealed significance; [cultivating] the unsurpassed Great Vehicle is then called the revealed significance, as expounded in the "Chapter on Tathāgata's Nature" in the 6th scroll of the *Nirvā□a Sūtra*. [The above] clarification are quoted according to the sūtra, not completely copied successively[51].

4.3. The third is the clarification of the [method of] relying on Genuine Teachers for bodhisattvas of inferior capacity, wherein are two stages:
4.3.1. The first is what the Buddhas and bodhisattvas expounded to those of the Two Vehicles and the worldlings in one place. Since the superior is the same as the inferior, it is called the inferior Genuine Teachers;
4.3.2. The second is what only the Buddhas and bodhisattvas expounded in one place, which is called superior Genuine Teachers. Why? In the first part of Genuine Teachers only the agreeable is clarified but its disagreeable is not, so it is the inferior one; in the second part, both the agreeable and disagreeable are fully expounded, so it is the superior one.

4.3.1. The first is Genuine Teachers for bodhisattva of inferior capacity, wherein are four kinds:
4.3.1.1. Becoming intimate with the good friends;
4.3.1.2. Whole-heartedly listening to the Teachings;
4.3.1.3. Fixing the mind on thinking;
4.3.1.4. Cultivating and practicing according to the Teachings.

4.3.1.1. The first is becoming intimate with the good friends, which is just another name of the Genuine Teachers. Why they are called Genuine Teachers? The Genuine Teachers, can instruct the sentient beings severing far away from the Ten Evils and cultivating and practising the Ten Goods. Because of that significance, they are called Genuine Teachers. Furthermore, the Genuine Teachers, expound according to the Teachings, cultivate and practise as what they have expounded[52], wherein are five parts:
4.3.1.1.1. Clarifying [the Genuine Teachers] severing themselves from the Ten Evils, and also instructing the other persons severing the Ten Evils;
4.3.1.1.2. [The Genuine Teachers] cultivating bodhi themselves, and also being able to instruct other persons to cultivate and practise bodhi ;
4.3.1.1.3. [The Genuine Teachers] can cultivate and practise themselves faith and precepts, charity, learning widely and wisdom; Also they can

113 善友者，即是善知識異名。何故名爲善知識？善知識者，能教衆生遠離十惡修行十善。以是義故名

114 善知識。又善知識者，如法而說如說修行， 於中有五段：一者明自離十惡，亦教他離十惡；二者自修菩

115 提，亦能教他修行菩提；三者自能修行信戒佈施多聞智慧，亦能教他信戒佈施多聞智慧；四者所

116 作之事不求自樂，常爲衆生而求於樂；五者見他有過不訟其短，口常宣說純善之事，以是義故名善

117 知識。能令善法增廣，如《月生相以知經》說。第二明專心聽法者，於中有六段：一者因是親近善知

118 識複得了達，作十二部經甚深之義， 三明因十二部經□□□□□□□□□□真聽法者，即是聽

119 受《大涅槃經》；四者明因聞正法名八聖道。以八聖道能斷貪欲嗔恚愚癡故名聽法。十一空。以此諸空

instruct other persons [to cultivate and practise] faith and precepts, charity, learning widely and wisdom;
4.3.1.1.4. What [they] have done is not attempted for their own happiness, but permanently for the sake of the sentient beings they seek the happiness;
4.3.1.1.5. Seeing other persons having faults, [they] would not criticize their shortcomings, and they always transmit and expound the pure good things. Because of that significance they are called the Genuine Teachers, who can make the good dharma increased and expanded, as expounded in the *Sūtra of Knowing through the Increasing Phase of the Moon.* [53]

4.3.1.2. Clarifying whole-heartedly listening to the Teachings, wherein are six parts:
4.3.1.2.1. Because of becoming intimate with the Genuine Teachers, [the bodhisattvas] obtain further the enlightenment, and understand the Twelve Divisions of Buddhist Canon of very deep significance.
4.3.1.2.2. Clarifying because of the Twelve Divisions of Buddhist Canon □□□□□
[4.3.1.2.3.] □□□□□ the real listener of the Teachings, are namely listening and receiving the *Great Nirvā□a Sūtra*;
4.3.1.2.4. Clarifying because of hearing the True Teachings[54] which is called the Noble Eightfold Paths. By means of the Noble Eightfold Paths one can sever from the greed desire, anger, wrath, foolish and ignorance, therefore it is called “listening to the Teachings”.
4.3.1.2.5. [Those who listen to the Teachings are called] [55] the eleven kinds of emptiness. Because of these emptinesses in all Teachings no forms and features are made.
4.3.1.2.6. Clarifying because of hearing the Teachings und even finally [one arouses] the mind to anuttarā-samyak-sa□bodhi[56]. For instance a sick person, though he hears the instructions of the doctor or the names of the remedies his illness can not be healed. Because of taking and eating [the medicines] his illness can be dismissed. Though one may listen to the twelve deep Teachings of causes and conditions, one can not sever all afflictions. Mainly because of[57] fixing the mind on good thinking, [the afflictions] can be removed and severed”[58].

4.3.1.3. The third is fixing the mind on thinking, wherein are three samādhi[59]:

120 於一切法不作相貌；六者明因此闻法乃至究竟阿耨多羅三藐三菩提心。譬如病人，雖聞醫教及藥

121 名字不能愈病。以服食故能得差病。雖聽十二深因緣法，不能得斷一切煩惱。要因繫念善思惟故，能

122 得除斷。 第三繫念思惟者，於中有三三昧：一者空於二十五有，不見一實；二者无作者於二十五

123 有，不作願求；三者明无相，无有十相。所謂色相、聲相、香相、味相、觸相、生相、住相、滅相、男相、女相。第四

124 明如法修行者，即是修行檀波羅蜜，乃至般若波羅蜜。知陰入界真實之相，亦知聲聞緣覺諸佛同

125 於一道而般涅槃法者，即是常、樂、我、淨、不生、不老、不病、不死、不饑、不渴、不苦、不惱、不退、不沒。 第二

126 上善知識者，有四種如上說，於中有三段：一者持說，是第一真實善知識；二者明人後，所謂菩薩

4.3.1.3.1. The emptiness in the Twenty-five [Stages of] Existences[60], without a single reality;
4.3.1.3.2. No maker in the Twenty-five [Stages of] Existences, making no desire and demand;
4.3.1.3.3. Clarifying the non-existence of marks, the non-existence of the Ten Marks. Namely the marks of materiality, the marks of sound, the marks of scent, the marks of taste, the marks of touch, the marks of life, the marks of abiding, the marks of extinction, the marks of men, the marks of women.[61]

4.3.1.4. The fourth is the clarification of the cultivating and practicing according to the Teachings, namely are cultivating and practicing dāna-pāramitā, and even to prajñā-pāramitā. Knowing the true real marks of the [Five] Aggregations, [Twelve] Entrances and [Eighteen] Realms, and also knowing[62] the Teachings of the complete nirvā□a of the voice-hearers, solitary realizers and all Buddhas in the same way, that is, permanence, bliss, self, and purity, no birth, no oldness, no illness, no death, no hungriness, no thirstiness, no sorrow, no annoyance, no backsliding, no submergence.[63]

4.3.2. The second is the superior Genuine Teachers, which have four kinds as expounded above, wherein are three parts:
4.3.2.1. Those who hold and expound [the Teachings to others], are the first true real Genuine Teachers;
4.3.2.2. Clarifying those who are beyond the human beings, namely bodhisattvas and the Buddhas World-Honoured Ones;
4.3.2.3. Clarifying difference of control[64]: “the first is absolute mild words; the second absolute criticism; the thirdly criticism with mild words”[65], as expounded in the 25th scroll of the *Nirvā□a Sūtra*. The above clarifies the significance according to scriptures, not copies completely.

4.4. The fourth is the clarification of the bodhi seeds of bodhisattvas of less capacity are the mind of uprightness and straightforwardness[66], as expounded in the *Vimalakīrti Sūtra*[67]. Why? All things in the world are called the inferior and latter ones, and are called the mind of superior straightforwardness understanding □□□ the head of the line. Therefore knowing those are expounded for the bodhisattvas of inferior capacity, wherein are two parts:

127 諸佛世尊；三者明出行分齊：一畢竟軟語；二畢竟呵責；三軟語呵責；如《涅槃經第廿十五卷》中說。上

128 依經明義，非次第抄也。 第四明下根菩薩菩提種子質直心是，如《維摩經》說。何以故？於世界中一切

129 者，名爲下後者，名爲上直心解□□□行首。故知爲下根菩薩說，於中有兩段：一者就他身明直心；

130 二者就自身明直心。第一明他身直心者。於他身明唯有遏惡揚善。 上人語下經文： 云何直心？菩

131 薩摩訶薩於諸衆生作質直心，一切衆生若遇因緣則生諂曲，菩薩不爾。何以故？善解諸法悉因緣

132 故。菩薩摩訶薩雖見衆生諸惡過咎終不說之。何以故？恐生煩惱。若生煩惱則墮惡趣。如是菩薩若

133 見衆生有少善事則讚歎之。雲何爲善？所謂佛性。贊佛性故令諸衆生發阿耨多羅三藐三菩提心。

134 乃至結句。善男子，以是義故菩薩摩訶薩贊人善不訟彼缺，名質直心。第二明自身直心者，

4.4.1. Regarding others clarifying the mind of straightforwardness;
4.4.2. Regarding oneself clarifying the mind of straightforwardness.

4.4.1. The first is the clarification of the mind of straightforwardness regarding others. To others clarifying only stopping the evils and praising the goods. Above are human words and below are scriptural texts.[68] “What is the mind of straightforwardness? Bodhisattva mahāsattva makes his mind of uprightness and straightforwardness for the sentient beings. If all sentient beings are under the causes and conditions they will have the mind of flattery and perversion. The bodhisattva does not. Why? Because he well understands that all Teachings are entirely causes and conditions. Though the bodhisattva mahāsattva sees the evils, faults and shortcomings of the sentient beings, he does not say it at all. Why? [Because he is] afraid of having afflictions. If having afflictions he will fall into the evil paths. Thus if the bodhisattva sees a few good deeds of sentient beings, he will then praise them. What is the good? It is namely the Buddha Nature. Because of praising the Buddha Nature [he] causes the sentient beings to arouse the mind to anuttarā-samyak-sa□bodhi[69], even until the end sentence. Good sons, because of that significance bodhisattvas mahāsattva praises the goods of others, but do not criticize their shortcomings, and that is called the mind of uprightness and straightforwardness. “[70]

4.4.2. The second clarifies the mind of straightforwardness regarding oneself. Within oneself only clarifying exclusively □□□□□□□□. Above are the human words and below are scriptural texts: “Furthermore, good sons, what is the mind of uprightness and straightforwardness of bodhisattvas? Bodhisattva mahāsattva never commits the evils. If he has a fault he confesses and repents them immediately[71], and never covers and hides them before the teacher and mates, and is ashamed and self-criticizing, and dare not to repeat them again, from the light fault he arises the thought of extreme grave.
If some persons interrogate him, he answers ‘really committed’. Further they ask: ‘Is the fault good or not?’ He answers: ‘not good.’ Further they ask: ‘Is the fault virtuous or not?’ He answers: ‘not virtuous.’ Further they ask: ‘Is the fault the good result or non-good result?’ He answers: ‘It is a fault and really no good result.’ Again being asked: ‘Who has committed that fault? Wouldn't it be done by the Buddhas, the Teachings and the monks?’ He answers: ‘Not the Buddhas, the

135 於自身中唯明專□□□□□□□□。上人語下經文： 複次善男子，雲何菩薩質直心？菩薩摩訶薩

136 常不犯惡，設有過失於時懺悔，於師同學終不覆藏，慚愧自責不敢複作，於輕罪中生極重想。若人

137 詰問，答曰：實犯。複問是罪爲好不好？答言：不好。複問：是罪爲善不善？答言：不善。複問：是罪是善果耶不

138 善果耶？答曰：是罪，實非善果。又問是罪誰之所造？將非諸佛法僧所作？答曰：非佛法僧，我所作也。乃

139 是煩惱之所構集。以直心故信有佛性。信佛性故則不得名一闡提也。以直心故名佛弟子，若受衆

140 生衣服飲食臥具醫藥種各千萬不足爲多，是名菩薩質直心也。如《涅槃經第二十六卷第九功德

141 品》說。第五明下根菩薩受戒及護戒境界法□□□□：一者明所受戒，明說二十四；二者明護

142 戒法，以陀羅尼咒戒□□□□□□□□□□□□□□□□□及在家出家□□；四者明護戒

143 大德，明是所明者皆□□□□□□□□□□□□□□□得□□及等，受戒護戒等皆爲下根菩

Teachings and the monks, I have committed it, which is a construction and aggregation of the afflictions.' Because of the mind of straightforwardness [he] believes the existence of the Buddha Nature [in sentient beings]. Because of the belief in the Buddha Nature [they] should not be called icchantika[72]. Because of the mind of straightforwardness they are called Buddha's disciples. If they receive from sentient beings clothes, foods and drinks, beddings and medicines and other thousands of kinds [things], it would not be too much, and that is called the mind of uprightness and straightforwardness of bodhisattvas", as expounded in the 9th "Chapter on Virtue" in the 26th scroll of the *Nirvā□a Sūtra*.[73]

4.5. Clarifying receiving the precepts and the methods of the realm of protecting the precepts for bodhisattvas of inferior capacity □□□□
4.5.1. Clarifying the received precepts. Clarifying expounding the Twenty-four [Precepts];
4.5.2. Clarifying the methods of protecting the precepts. By means of dhāra□ī precepts □□□□□□□□
4.5.3. □□□□□□□□□□□ as well as those who stay at home or leave home[74] □□
4.5.4. Clarifying the great virtue of protecting the precepts. Clarifying those which are clarified all □□□□□□□□□□□□□□□□obtain □□ and so on, receiving the precepts and protecting the precepts and so on are all for the bodhisattvas of inferior capacity □□□□ two □□□□□□□□□□□□□

4.5.4.1. If the hungry sentient beings beg for foods, drinks and beddings, the one who refuses to give commits a grave offence;
4.5.4.2. If one indulges oneself in sensual pleasures without distinguishing birds and beasts, one commits a grave offence;
4.5.4.3. If one sees a bhik□u housing a wife and arbitrarily criticizes the fault, one commits a grave offence;
4.5.4.4. If one see someone anxious and depressed and going to commit suicide, and one increases their anger with his own intention and destroys his root of life, one commits a grave offence;
4.5.4.5. If one takes the money and valuables on the wild road, one commits a grave offence;
4.5.4.6. If one sees someone going to kill lives, and one praises with pretty words to makes him angry and furious, one commits a grave offence;

144 薩□□□□兩□□□□□□□□□□□□□□一者饑餓衆生求飲食臥具不與者犯重；二者嬉

145 欲无度不擇禽獸者犯重；三者若見比丘畜有妻子隨意說過者犯重；四者見人憂愁欲自喪身以

146 已意增他瞋敗他命根者犯重；五者取曠路中財寶者犯重；六者見他欲害命以美言贊令他瞋恚

147 者犯重；七者見他欲燒僧坊不盡心諫者犯重；八者若見若聞他犯重罪若不作三到喚教忏悔者

148 犯重；九者見有人作五逆罪不呵勸舍者犯重；十者見聞他欲與大善事更起瞋恚壞他者犯重；十

149 一者見他耽食嗜酒當以已情往呵除自因緣犯重；十二者見人嬉他婦女語他夫者犯重；十三者

150 視他怨家作怨家想者犯重；十四者見他視怨家如赤子語他何能視此人如赤子犯重；十五者見

151 他聚鬥助力槌打者犯重；十六者見他伏匿事向他说令他大瞋恚者犯重；十七者見聞他善事云

4.5.4.7. If one sees someone going to burn the lodges of monks, but one does not remonstrating with all his heart, one commits a grave offence;
4.5.4.8. If one sees and hears someone committing grave offences but if one does not call him out for three times, one commits a grave offence;
4.5.4.9. If one sees someone committing the Five Heinous Sins but if one does not loudly persuade him to give up, one commits a grave offence;
4.5.4.10. If one sees and hears others going to do great charitable deeds, if one becomes jealous and angry and spoil it, one commits a grave offence;
4.5.4.11. If one sees someone indulging himself in food and addicted in liquor, and if one regards it as his own situation and reproves him to remove one's own causes and conditions, one commits a grave offence;
4.5.4.12. If one sees someone having sex with another one's wife, and if one tells her husband that, one commits a grave offence;
4.5.4.13. If one regards another one as adversary and make an adversary thought, one commit a grave offence;
4.5.4.14. If one sees someone regarding their adversary as innocent baby, and if one says to them how he can regard that man as an innocent baby, one commits a grave offence;
4.5.4.15. If one sees others assembling to fight, and if one joins the battle and beats with hammer, one commits a grave offence;
4.5.4.16. If one sees someone conceal secrets, and if one exposes it to the others and makes him furious, one commits a grave offence;
4.5.4.17. If one sees and hears someone doing good deeds, and if one says that all are impracticable, one commits a grave offence;
4.5.4.18. If one sees others building a pagoda or temple or building a monastery on the wide road, but if one does not help, one commits a grave offence;
4.5.4.19. If one sees and hears someone leaving the Genuine Teachers and becoming intimate with the evil friends, but if one does not persuade to give up, one commits a grave offence;
4.5.4.20. If one is eager to go for the sake of settling his own business in house of Ca□□āla[75], the place of fiend and the place of evil dog, in the house of two vehicles of direct disciple [and solitary realizer], one commits a grave offence;
4.5.4.21. If one sees and hears someone possibly killing, but if one pretends not to see and hear the possible killing and wants to eat the flesh, one commits a grave offence;

152 都不得作者犯重；十八者行於曠路見人營塔廟營精舍不助者犯重；十九者見聞有人離善知識

153 親近惡友贊好不勸舍者犯重；二十者於旃陀羅家惡人處惡狗處聲聞二乘人家除已事急往者

154 犯重；二十一者見聞疑殺作不見聞疑想食此肉者犯重；二十二者見聞疑煞作不見聞疑煞若不

155 食此肉者犯重；二十三者解於方便知衆生根若謂不說者犯重；二十四者或见諸菩薩及余诸见，

156 悉不得向人說，現身得鄣道法，得白癩病，或時愚癡，或時瞽盲，或目眩。妄想分別諸法要，得愚癡。

157 賢劫千佛□□□作王子時□□□□不者作行諸佛求受二十四戒人□□□□□□□□□□□

158 養□佛□□□□佛□來□□□□□經》第一卷中說。此依經此義□□□□□□□□□□□□□

159 □佛□□□□尔时文殊师利及五百大弟子心有少疑。佛知其意即时告言，如汝所念行者应

4.5.4.22. If one sees and hears someone possibly killing, but if one pretends not to see and hear the possible killing and if he does not eat the flesh, one commits a grave offence;
4.5.4.23. If one understands the expedient means and knowing the capacity of sentient beings, but one does not speak, one commits a grave offence;
4.5.4.24. If one [observes the precepts and thus he] possibly sees the bodhisattvas as well as the other [bodhisattvas], one should not say that to the others. [If not, one] appears to be obstructed of the Way and the Teachings, and falls ill of leprosy, or will be stupid and insane sometimes, or speak evil or blind, or be dazzled. [One will] hope in vain to differentiate the Teachings, and falls ill of delusion and confusion. [76]
Thousand Buddhas of the Good Eon □□□ as they were princes □□□□ not make the practices the Buddhas sought to receive the Twenty-four Precepts persons □□□□□□□□□□□ sustaining □ Buddha □□□□ Buddha □ coming □□□□□ as expounded in the first scroll of □ *Sūtra*. According to the Sutra that significance □□□□□□□□□□□□□□ Buddha □□□□

[77]"At that time Mañjūśrī and five great disciples had some doubts in their minds. Buddha knew their thoughts and then told them: 'As you think that a practitioner should cultivate five things to observe the nature of precepts. Namely, not to offend the significance of dhāra□ī; not to slander the scriptures of universal equality; not to see the mistakes of others; not to praise the Great Vehicle and not to defame the Small Vehicle; not to leave the good friends and always speak of the wonderful deeds of sentient beings. The above five things are practitioner's actions not to offend the nature of actions and not to offend the nature of precepts.
[78] You should not say what you have seen in the superior realms; also should not say the things you have done either good or ugly; also should smear the ground [with the scents] three times everyday; also should recite one time each day; and confess and repent one time each day. The above five things are practitioner's actions not to offend the nature of precepts.
Further, good sons, there are still five things: If a bhik□u conducts this practice and has contact with white clothed people[79], he should not offer sacrifice to the ghosts and gods; also not despise the ghosts and gods; also not break the temples of the ghosts and gods; and if someone offers sacrifice to the ghosts and gods, he should not despise them; also not

160 修五事持诸戒性。所谓不犯陀罗尼义，不谤方等經，不见他过，不赞大乘不毁小乘，不离善友常说

161 衆生妙行。如是五事是行者业不犯业性不犯戒性。不说上界所见，亦不说已所行好丑之事，亦应日日

162 三時涂地亦应日诵一遍，日一忏悔。如是五事行者业不犯戒性。复次善男子，复有五事：若有比

163 丘行此法者及与白衣，不得祭祀鬼神，亦不复不得轻于鬼神，亦复不得破鬼神庙。假使有人祭祀鬼

164 神亦不得轻，亦不得与彼人来往。如是五事是行者业护戒境界。复次善男子，复有五事：不得与谤

165 方等經家 往來，不得与破戒比丘往来，破五戒优婆塞亦不得往来，不得与猎师家往来，不得与常

166 說比丘过家往來。如是五事是行者业护戒境界。复次善男子，复有五事：不得与脑皮家往来，不得

167 與蓝染家往來，不得与養蚕家往来，不得与压油家往来，不得与掘伏藏家往来。如是五事是行者

168 業护戒境界。復次善男子，复有五事：不得与劫贼家往来，不得与偷盗家往来，不得与烧僧坊人往来，不得

169 与偷僧祗物人往来，不得与乃至偷一比丘物人往来。如是五事是行者业护戒境界。复有五事：不

170 得与畜猪羊鸡狗家往来，不得与星历家往来，不得与淫女家往来，不得与寡妇家往来，不得与沽

deal with him. The above five things are practitioner's actions to protect the realm of the precepts.
Further, good sons, there are still five things: you should not deal with those who slander the scriptures of universal equality; not deal with the *bhik□u* who has broken the precepts; also not deal with upāsaka who has broken the five precepts; not deal with hunters; not deal with those who always speak of the mistakes of *bhik□us*. The above five things are practitioner's actions to protect the realm of the precepts.
Further, good sons, there are still five things: you should not deal with the barbers; not deal with the dyers; not deal with silkworm keepers; not deal with oil pressers; not deal with mouse diggers. The above five things are practitioner's actions to protect the realm of the precepts.
Further, good sons, there are still five things: you should not deal with thieves; not deal with robbers; not deal with those who has burnt dwelling of monks; not deal with those who has stolen things from monks; not deal with those who has stolen even one thing from bhik□u. The above five things are practitioner's actions to protect the realm of the precepts.
[80]Further there are still five things: you should not deal with those who keep pigs, sheep, hens and dogs; not deal with astrologer; not deal with lusty women; not deal with widows; not deal with liquor seller. The above five things are practitioner's actions to protect the realm of the precepts.
Good sons, for such seven kinds of five things the practitioner should deeply contemplate the root and origin, and then give up all other things in the same way'." [81]

□□□

171 酒家往來。如是五事行者业护戒境界。善男子，如是七科五事行者应深了观根源，然后舍离其余

172 诸事亦复如是。□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

173 □□□□□□□□□□□□□□□□□□□□

201 不得□□不得□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□
202 不得□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□
203 □□□□□□□□□□□□□□□□□□□□□□□□□□□□此上住□□□□□□□□□□
204 皆言□□□後惡□□□□□□□□□□□□□□□□□□□□說□□□□□□□□□□

205 □共比丘□□□□□□□□□□□□□□□□□□□□□□□何以故□□□□□□□□□□
206 □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□
207 識□□□□非□□□□□□□□□□□□□□□□□□□□□名此惡持□□□□□□□□
208 時中衆生說法明知□□□□□□□□□□□□□□□□□□□□明行不□□□□□□□□□□
209 爲□□是一人是故□□□□□□□□□□□□□□□□□□□□苦惱比丘□□□□□□□□
210 □□□□二正法滅後年於□□□□□□□□□□□□□□□□□□大□□□□□□□□□□
211 □□□□不得法三明中西□□□□□□□□□□□□□□□□上下不□□□□□□□□□□
212 □□□□不言禮餘□□□□□□□□□□□□□□□□□明信□□□□□□□□□□□□
213 □□能六者明起行分齊不輕□□□□□□□□□□□□□□□□王□□□□□□□□□□
214 □□□不餘行利益多不於□□□□□□□□□□□□□□□此□□□□□□□□□□□□□□
215 能□於二明得六根清淨二明更□□□□□□□□□□□□□□□□□□□□□□□□□□□□
216 處□□□□人相延心歸化人不□□□□□□□□□□□□□□□□□□□□□□□□□□□□
217 明不信人等損益多少□□□益多少地上根利益多少□□□□□□□□□□□□□□□□□□
218 □□□千□於阿鼻地獄中大苦惱其□□中四火地獄□□□□□□□□□□□□□□□□□□
219 □□□□菩薩□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□
220 □□□□多者□道人□少者爲下人□□□□□□□□□□□□□□□□□□□□□□□□□□□□
221 □□明多二者明少如《法華經第六卷藥王菩薩本事品》□□□□□□□□□□□□□□□□□□
222 □□□□□經中但道爲菩薩請不論□□□□□出具足煩惱未有断者□□□□□□□□□□

despise □□□□□ □□□□□□□□□□□ king □□□□□□□□□□□ □□ □ no other practices much benefits not from □□□□□□□□□□□□□ □ this□□□□□□□□□□□ □□□can □ at the two clarifications get the six sense organs cleared and purified the two clarifications more □□□□□□□□ □□□□ □□□□□□□□□□□□□□□ place □□□□ people each other extend the mind transformed the one not □□□□□□□□ □□□ □ □□□□□□□□□□□□□□□ clarifying the amount of gain and loss of the persons of unbelieving etc. □□□ gain the amount on the ground the roots the benefits amount □□□□□□□□□□□□□□□□□□□□ thousand□ in the Avīci Hell the grave sufferings and distress which □□ in the Four Fire Hell □□□□□□□□□ □□□□□□□□□□□□ bodhisattva □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ □□□□□□□□ more those □ the way persons □ less those are the inferior persons □□□□□ □□□ □□□□□□□□□□□□ □□□□□□ clarifying much, the second clarifying less, as expounded in the “Chapter of Past Events of the Bodhisattva Medicine King ” in the 6th scroll of the *Lotus Sūtra* □□□□□□□□□□□□□ □□□□□□□□□□ in the Sūtra just speak for the bodhisattva praying regardless of □□□□□ out the perfection afflictions unsevered those who □□□□□□□□□□□□□□□□ answer if one can seven times seven days each day especially eat rice[84] one □□ □□□□ etc □□□□□□□

“Further, the bodhisattva for the sake of the Teachings, cut out his body as lamp, wound his skin and flesh with felt, poured with butter oil and burnt it as an incense stick. The bodhisattva said the following words[85]: ‘Compared with the sufferings in the hell such sufferings are less than one of hundred thousand myriads. You have endured great sufferings since immeasurable hundred thousand eons, and have not brought out benefit. If you can not endure such light suffering, how can you save the suffered sentient beings from the hell?’ As the bodhisattva mahāsattva made such contemplation he felt no pain from his body and his mind did not withdraw, not move and not turn back. The bodhisattva then should have deeply known himself, ‘I will surely obtain the anuttarā-samyak-sa□bodhi’ □□□□[86] For the sake of the Teachings [the bodhisattva] could give his head and eyes, marrow and bones, hands and feet, blood and flesh to the sentient beings; nail his body with nails, throw himself to the rock and jump to fire. □□□ must obtain the anuttara-samyak-sa□bodhi”, as expounded in the 33rd scroll[87] of the *Nirvā□a Sūtra*. □□□□□□□ the ascetic practices the difference the method there are □□ stages: First the two

□□□□□□□□□ texts extensively expounded; Thirdly in the one meal of a

223 □□□□□□答或能七七日日别食米一□□□□□□等□□□□□□□复次菩萨为法因

224 缘，剜身为灯毡缠皮肉，蘇油灌之燒以爲炷。菩萨作言：如是苦者于地狱苦百千万分未是一分，汝

225 于无量百千劫中受大苦恼都無利益，汝若不能受是轻苦，雲何而能于地狱中救苦众生？菩萨摩

226 诃萨作是观时身不覺苦，其心不退不動不轉。菩萨尔时应深自知，我定当得阿耨多罗三藐三菩

227 提。□□□□爲法因緣，能以頭目髓骼手足血肉施以众生，以釘釘身，投岩赴火。□□□当得阿耨

228 多罗三藐三菩提。如《涅槃經》第三十三卷中说□□□□□□□苦行分齊法者有□□階：一者兩

229 □□□□□□□□□文廣說三者於一食中三分□□□□若一食中食 五者□□食中三分

day three portions □□□□ if the one meal of a day and the midday meal; Fifthly □□ in the one meal of a day three portions □□□□□□ three methods □□ expounded; Sixthly in the one meal of a day four portions of meal one □□□□□□ as expounded in the "Chapter of Twelve Dhūta" in the 6th scroll of the *Jewel Cloud Sūtra.* □□□□□ day □□□ only □three garments, as expounded in the scriptures of the Great Vehicle and the Small Vehicle □□□ places □

in the twelve Dhūta the fully expounded ascetic practices of dwelling: The first □□□□; The second is dwelling in the open air. Dwelling in the open air, means sitting in the open air in spring, autumn, winter and summer, not dwelling behind walls, also not dwelling under the trees, also not dwelling on assistance of haystacks, not dwelling in the concealed place of mountains, not dwelling by the banks of rivers, without equipments against the cold, without equipments against the wind, without equipments against the rain, without equipments against the heat, without equipments against the dew. [If] the bodhisattva dwells in the open air and feels pain from his body, and his body becomes weak and feeble, then he should go to the dwelling of the monks, as expounded in the "Chapter of Twelve Dhūta" in the 6th scroll of the *Jewel Cloud Sūtra*.

The *Jewel Cloud Sūtra* is the scripture of the Great Vehicle briefly □□□□□□□ the scriptures of the Great Vehicle throughout extensively expounded. The following clarifies the significance according to the sūtra, not copied completely. Not arousing the mind to enlightenment briefly finally twenty coming extensively clarifying the significance of existence the emptiness □□□□□□□□□ significance □ significance explaining and expounding the 3rd scroll of the *Buddha Store Sūtra* clarifying the story of Tathāgata getting saved. Above are the human words and below are scriptural texts: □□□□ □ beginning □□□□□□□□□□□offer and sustain two hundred and sixty-three Buddhas practicing the Way, offer □ Buddha from not obtaining □□ explanation because not obtaining Buddha's prediction and even □□□□□□□□□□ in the middle of which hear again those in the ten thousand of eons □□□□ in the ten thousand of eons the first one thousand eons the first five hundred eons offer and sustain nine □□□□□□□□□□□ fourteen thousand □ the □ Buddhas □□□□□ the 2nd scroll first clarifying Tathāgata obtaining □□□□□□□□□□□□□□□□□□□□□□□□□□ go and visit □□□□□□many □□□□□□□□□□□□

230 □□□□□□三法□□說六者一食中四分食一□□□□□□《寶雲經第六卷十二頭陀》中說

231 □□□□□天□□□唯□三衣，如大乘小乘經之□□□處□十二頭陀中具說坐中苦行者一

232 者□□□□二者露坐。露坐者，露地坐春秋冬夏，不依牆壁住，亦不依樹下住，亦不依襄草積住，不

233 依山掩處住，不依河岸住；不作鄣寒具，不作鄣風具，不作遮雨具，不作遮熱具，不作鄣露具。菩薩在

234 於露地而身有痛，形體羸弱應至僧坊。如《寶雲經第六卷十二頭陀》中說。《寶雲經》是大乘經略□□

235 □□□□□大乘經處處廣說 後依经明義非为尽抄。 不發菩提心略 竟廿來廣明有義空□□□

236 □□□□□□義□義解說 《佛藏經》第三卷明如來得救記。 上人語下經文： □□□□□始□□

237 □□□□□□□□□供養二百六十三佛所修道供□佛由不得□□解故不得佛授記乃至□

238 □□□□□□□□□於其中間聞複是萬劫中毗□□□□萬劫中初一千劫初五百劫中供養九

239 □□□□□□□□□□□萬四千□諸□波佛□□□□□第二卷初明如來得□□□□□□□

240 □□□□□□□□□□□□□□□□□行詣□□□□□□多□□□□□□□□□□□□

[1] In a manuscript (Stein #3446) it is definitely stated as "taking refuge in (*gui* 歸) Buddhas, the Dharmas and the Sanghas, and saving (*du* 度) the sentient beings".
[2] According to *Da zhi du lun* 大智度论, the true-body 真身 refers the dharma-body 法身 and reward-body 报身 of the Buddha. See T#1509, 25.278a. But in *Shi dasheng lun* 释大乘论 it is said that there are three kinds of bodies of Buddha: true-body, reward-body and response-body. See T#1592, 31.97a.
[3] See T3, no.159, p289c.
[4] literally it is person 人, but in the light of the explanation below we know that the word *ren* refers to the various kinds of persons
[5] The "Two Vehicles" refer to voice-hearers and solitary realizers.
[6] T14, no.475, p539, and no.542, p544-546.
[7] In the *Srimala Sutra* the Vehicle of human beings and that of heavenly beings are combined into one Vehicle.
[8] See T9, no.278, p418a and T10, no.379, p77b.
[9] Here the structure of the text has been changed. According to the explanation in the beginning here 1.1.5. and 1.1.6. should be originally 1.2.1. and 1.3.2.
[10] The "Ten Levels" here refer to the forty-first through the fiftieth stages in the path of the bodhisattva, which are designated as one through ten. In various scriptures, each of the stages is associated with the subjugation or elimination of a certain type of obstruction to enlightenment.
[11] "普狂慧" is the shortened form of "智普狂慧".
[12] The three pāramitā are correspondingly Perfection of charity, perfection of wisdom and perfection of non wisdom
[13] Here the character "有" was not carved. Compare T13, no.374, p521a.
[14] In T it is "无无无果报" instead of "无有无果报". See T12, no.374, p523a.
[15] See T9, no.278, p417.
[16] incalculable
[17] T28, no. 1161, p664a.
[18] The two character "口业" are here added by the transcriber according to the context. And 3.1.3. is not identifiable.
[19] T28, no. 1161, p664a.
[20] The four grave crimes: (1) killing a human being, (2) stealing, (3) sexual intercourse and (4) lying. Five heinous crimes: (1) killing one's mother; (2) killing one's father; (3) killing a *Arhat*; (4) to wound the body of the Buddha; (5) to destroy the harmony of the sangha.
[21] Literally it is 方等 "Universal equality".
[22] T28, no. 1161, p664b.
[23] See T30, no.1161, p664a.
[24] T31, no. 1339, p656c.
[25] The Sentence is actually quoted from the *Great Universal Equality Dhāra□ī Sūtra*. See T31, no.1339, p656c.
[26] The character "已" after "清淨" is not carved. See T9, no.262, p51.
[27] A transliteration of the Sanskrit, which means a vast number or incalculable.
[28] C.f. T09, no.262, p51a.
[29] See T09, no.262, p550c.
[30] See T12, no.374, p497c.
[31] See T12, no.374, p450-451.
[32] The carved character is originally "諸", which is emended by the transcriber to "欲".
[33] One billion worlds, constituting the domain of the Buddha. A world consists of the world of desire and the first heaven of the world of form. It is a way of describing the vastness and interwoveness of the universe in ancient Indian cosmology.
[34] Though it is literally identical with *Shizhijing lun* 十地经论, rather than the said the "Chapter on Ten Grounds" of the *Flower Garland Sutra*. Compare T36, no.1522, p155b.
[35] See T9, no.278, p419c.
[36] According to the scriptures the rock, or mountain, *Pratāla*, is on the bottom of the ocean, just above the lut purgatory.
[37] This paragraph follows the last quotation in the *Flower Garland Sutra*. See T9, no.278, p419.

[34] Though it is literally identical with *Shidijing lun* 十地經論, rather than the said the "Chapter on Ten Grounds" of the *Flower Garland Sutra*. Compare T26, no.1522, p155b.

[35] See T9, no.278, p489c.

[36] According to the scriptures the rock, or mountain, *Pātāla*, is on the bottom of the ocean, just above the hot purgatory.

[37] This paragraph follows the last quotation in the *Flower Garland Sutra*. See T9, no.278, p489.

[38] See T9, no278, p490a.

[39] Perfections

[40] the four all-embracing (bodhisattva) virtues: (1) 布施 , giving what others like, in order to lead them to love and receive the truth; (2) 愛語 , affctionate, speech, with the same purpose; (3) 利行 , conduct proftable to others, with the same purpose; (4) 同事 , co-operation with and adaptation of oneself to others, to lead them into the truth.

[41] The *sibian* "四辯" is presumed based on P.2283.

[42] It is not verifiable if it is "如是" or "具足".

[43] "Good knowledge", or "a good and virtuous friend"; Those who lead one to the Buddhist way.

[44] This paragraph is quoted from the "Chapter on Accordingly Rejoice" of Mahāprajñāpāramitā Sūtra 摩訶般若波羅蜜經 rather than the same named chapter of the *Lotus Sutra*, See T8, no.223, p298a.

[45] See T12, no.374, p510.

[46] Non-retrogression. It seems that the quotation is incorrect, since the avaivartika are those who talked with Ananda, rather than one of the three stages.

[47] See T8, no.223, p276.

[48] See T9, no.278, p16a-b.

[49] enlightenment

[50] The four kinds of perons are Srotāpanna, Sakrdāgāmi, Angāmi, Arahat. See T12, no.374, p401.

[51] Compare T12, no.374, p401. It is indeed freely paraphrased, not directly quoted.

[52] It is "如法而说如说而行" instead of "如法而說如說修行" in T. The contents concerning not killing lives and correctly viewing are not quoted.

[53] There is no such sutra found in T. The passage is quoted from T12, no.374, p511a.

[54] In T it is "专心听法" instead of "因聞正法".

[55] There are still five characters "夫听法者名" before "十一空" in T.

[56] Supreme Correct Enlightenment

[57] In T it is "以" instead of "因".

[58] T12, no. 374, p511a.

[59] Perfect Absorptions

[60] The division of the three realms that sentient beings transmigrate through into 25 sub-realms. In the desire realm there are fourteen existences, in the form realm there are seven existences, and in the formless realm, four existences.

[61] C.f. T12, no. 374, p511b.

[62] In T it is originally "如"instead of "知".

[63] T12, no. 374, p511c.

[64] According the sutra here refers to the three kinds of shan tiaoyu "善調御" ( good controls). See T12, no. 375, p755b.

[65] T12, no. 375, p755b.

[66] The last word of this sentence should be 者 instead of 是.

[67] *The term* " 质直心" (the mind of uprightness and straightforwardness) is from Vimalakīrti Sūtra (T14, no.475, p543c), but the following quotations are from the *Great Nirvā□a*

*Sūtra*.

[68] It is an abbreviation of "已上人語引經說, 已下唯是經文說" (Above are expounding of human words with citation from scriptures, and the following are only the expounding of scriptural texts.). See Pelliot 2059, Sanjie fofa Vol.3 三階佛法 and Yabuki Keiki, *Sangaikyō no kenkyū, p*49-70.

[69] This passage from "云何直心" are from T12, no.374, p517-518.

[70] See T12, no.374, p519c.

[71] In T it is originally"即"instead of "於"

[72] A person whose roots of goodness are cut off and therefore cannot be saved.

[73] See T12, no.374, p519b-c.

[74] This is a reference to the two kinds practitioners: lay practitioner and monks.

[75] The lowest of Indian caste, or butcher's occupation.

[76] The 24 Precepts originate from the *Da fangdeng tuoluoni jing* 大方等陀罗尼经, but here the sentences are simplified and totally identical with a treatise written by Zhiyan (602-668) *Huayanjing nei zhangmeng deng za kong mu zhang* 华严经内章门等杂孔目章. Compare T21, no.1339, p645c-646a-b and T45, no.1870, p564a-b.

[77] From here the structure of the text is not verifiable.

[78] In T the five characters "复次善男子" are found. See T21, no1339, p657b.

[79] Referring to secular people, who, in ancient India, wore white clothes in contrast to the darker clothes of religious practitioners.

[80] In T the five characters "复次善男子" are found.

[81] The last sentence is presumed by transcriber according to the original sutra. See T21, no.1339, p657b-c.

[82] The sutra title Poruoxin jing 般若心经 is not without doubts, since it is hardly legible.

[83] The passage with "坐如来座"is possibly quoted from the Lotus Sutra, but it is not verifiable. See T9, no.262, p31.

[84] In Zhong'ahan jing 中阿含经 it is narrated eating rice in seven day etc. see T1, no.26, p675b.

[85] The four words "菩萨作言"is suggested by the transcriber, in the original sutra it is "菩萨尔时受是大苦，自呵其心而作是言". See T12, no. 374, p557c.

[86] There are still twelve characters in the original sutra in T: "菩薩爾時具足煩惱未有斷者" (The bodhisattva was then fully endowed with afflications which has not been severed.), but here is only place for four characters.

[87] This paragraph is excerpted from 32nd Volume of the *Great Nirvana Sutra* rather that 33rd Volume. See T12, no.374, p557b-c.

0 明诸大乘修多罗中世间出世间两阶人发菩提心同异法一卷 信行禅师撰

Clarifying the Methods in the Scriptures of the Great Vehicle about the Difference of the Mundane and Transmundane two Stages Persons Arousing the Mind to Enlightenment, One Scroll. Compiled by Meditation Master Xinxing

1 就內有兩段：一者明出世間十種善具足人發菩提心法；二者明世間十種惡具足人發菩提心法。 第一大段

Therein are two sections:
1. Clarifying the methods about arousing the mind to enlightenment of the transmundane persons who are fully endowed with ten kinds of goods[1];
2. Clarifying the methods about arousing the mind to enlightenment of the mundane persons who are fully endowed with ten kinds of evils.

2 明出世間十種善具足人發菩提心法者，如《華嚴經》諸大乘經論內廣說。第二大段明世間十種惡具足人

1. The first section is the clarification of the methods about arousing the mind to enlightenment of the transmundane persons who are fully endowed with ten kinds of goods, as extensively expounded in the *Flower Garland Sūtra* and the scriptures and treatises of the Great Vehicle.

3 發菩提心法者，於內有四段：一者明世間十種惡具足人觀空淺深分齊；二者明世間十種惡具足人敬衆生淺

2. The second section is the clarification of the methods about arousing the mind to enlightenment of the mundane persons who are fully endowed with ten kinds of evils, wherein are four parts:
2.1. Clarifying the depth and difference of contemplating the emptiness of the mundane persons who are fully endowed with ten kinds of evils;
2.2. Clarifying the depth and difference of revering the sentient beings of the mundane persons who are fully endowed with ten kinds of evils;
2.3. Clarifying the depth and difference of revering the dharma of the mundane persons who are fully endowed with ten kinds of evils;
2.4. Clarifying the depth and difference of knowing themselves the amount of their evils and severing the evil to accomplish the good practice of the mundane persons who are fully endowed with ten kinds of evils.

4 深分齊；三者明世間十種惡具足人敬法淺深分齊；四者明世間十種惡具足人自知已惡多少及離惡成善行

5 淺深分齊。 第一段明世間十種惡具足人自知已觀空淺深分齊者。何以故？爲破我見增上慢謗人謗法邪三

2.1. The first part is the clarification of the depth and difference of knowing themselves their contemplating the emptiness of the mundane persons who are fully endowed with ten kinds of evils. Why? Because for the sake of breaking the self-view, overweening pride, slandering the other people, slandering the dharma and the three wrong activities as well as the various kinds of evils.[2]

6 業等種種惡故。 一者就凡聖相對，明空有淺深。爲凡夫說有，爲聖人說空，如《大般涅槃經》說；二者就大乘法

7 內，明空有淺深。《方便品》內爲凡夫說法，明有多，明空少；《弟子品》內爲二乘聖人說法，明空多，明有少；《菩薩品》內爲菩

8 薩說法，空有俱廣說，如《維摩經》說； 三者就四乘根機中明空有淺深。人天位內，明有，不明空；二乘位內，明有

9 多，明空少；大乘位內，空有俱說，如諸經論內說。 四者□□□□□□□□□□□明新學菩薩得學空不得學空。

10 □曰：若學空舍有者，不合先學空。若能親近善知識，學空□□□□□□□□□□□□□□□□ □□是一乘

11 菩薩及三乘人所學法。證世間十種惡具足人等皆得空有並學。 一如《大□□□□□□□□□□ □□□念

12 □□說空定，不說有定； 二如《法華經》說，爲末法衆生说法，於內廣說空； 三如《大集月藏分》說，明爲天龍□

2.1.1. In comparison between worldlings and the sages clarifying the shallow and deep “emptiness” and “existence”. While the existence is expounded for the worldlings, the emptiness is expounded for the sages, as expounded in the *Great Parinirvā□a Sūtra*;

2.1.2. In the Teachings of the Great Vehicle clarifying the shallow and deep emptiness and existence. In the “Chapter on Expedient Means” the Teachings are expounded for the worldlings, whereas the existence is more clarified and the emptiness is less; in the “Chapter on Disciples” the Teachings are expounded for the sages of the Two Vehicles, whereas the emptiness is more clarified and the existence is less; in the “Chapters on Bodhisattvas” the Teachings are expounded for the bodhisattvas, whereas the emptiness and existence are all extensively expounded, as expounded in the *Vimalakīrti Sūtra*.

2.1.3. In the basic capacities of [those of] the Four Vehicles clarifying the shallow and deep emptiness and existence[3]. In the status of human and heavenly beings the existence will be clarified and the emptiness will not; In the status of the Two Vehicles the existence is more expounded and the emptiness is less; In the status of the Great Vehicle emptiness and existence are all expounded, as expounded in the scriptures and treatises.

2.1.4. □□□□□□□□□□□□clarifying if a newly awakend bodhisattva can learn the emptiness or not. □ said: If one learns the emptiness and abandons the existence, it is not proper for him to learn the emptiness in advance. If one can become intimate with the Genuine Teachers, one learns the emptiness □□□□□□□□□□□ □□□

[2.1.5. ] □□□□□ is the Teachings which the bodhisattvas of One Vehicle and the human beings of the Three Vehicles have learned testifying that the mundane persons who are fully endowed with ten kinds of evils should all learn both emptiness and existence.
2.1.5.1. As the *Great* □□□□□□□□□□□□□ thought □□ expounding that the emptiness is fixed, not expounding that the existence is fixed;
2.1.5.2. As expounded in the *Lotus Sūtra*, expounding the Teachings for the sentient beings of the degenerate age, therein the emptiness were extensively expounded;
2.1.5.3. As expounded in the “Chapter on the Moon Storehouse” of

13 □衆生說法，於內廣說空； 四如《大方廣十輪經》說，爲五濁惡世界衆生說法，於內廣說空； 五如《佛藏經》說，廣

14 □□法，出家人犯戒等多少，於內一部廣說空； 六如《摩訶般若經》說，一部明空，從首至末數數說法，欲滅時有

15 □□薩能行； 七如《月燈經》說，從首至末廣說空法，□□無量無邊勸爲佛滅後惡時內衆生說，於內一部廣說；

16 □□□□□□□□□□滅度五百年後出家人行□□□□廣說空。何以故？空有是法界法體。性若空有異學

17 □□□□□□□□□□□者戒，當凡夫二乘法所□□□十種惡具足人發菩提心，先須學空，即空起有 觀

18 □□□□□□□□□□□□□□佛菩薩亦應得□□□一如《華嚴經梵行品》說，就十法明觀空法：一身、二身

19 業、三意、四意業、五口、六口業、七佛、八法、九僧、十戒空。 如《摩訶衍經》說，解了諸法，如幻、如炎、如水中月、如虛空、如

20 響、如犍闥婆城、如夢、如影、如鏡中、如化□□□□□□□乃□□□□□大乘經論內所明空皆悉是。 第二段

the *Great Collection Sūtra*, clarifying that expounding the Teachings for the heavenly beings, dragons, □□, and sentient beings, wherein the emptiness is extensively expounded;

2.1.5.4. As expounded in the *Great Corrective and Extensive Ten Wheels Sūtra*, expounding the Teachings for the sentient beings in the evil world of the Five Defilements[4], wherein the emptiness is extensively expounded;

2.1.5.5. As expounded in the *Buddha Storehouse Sūtra*, extensively □□ the Teachings, the amount of the left-home people breaking the precepts etc, wherein the whole volume expounds the emptiness extensively;

2.1.5.6. As expounded in the *Mahāprajñā Sūtra*, which the whole volume clarifes the emptiness, and from the beginning to the end repeatedly expounds the Teachings, and before the extinction there are □□ [bodhisattva] can practise;

2.1.5.7. As expounded in the *Moon Lamp Sūtra*, which expounds the Teachings from beginning to the end, □□ immeasurable limitless persuading and expounding [the Teachings] for the sentient beings in the evil time after Buddha's nirvā□a, and within the whole volume [the emptiness] is extensively expounded;

□□□□□□□□□ [Buddha's] nirvā□a five hundred years after left-home people practise □□□□ extensively expound the emptiness. Why? The emptiness and existence are the dharma-body and the dharma-realm. The nature as the emptiness and existence different learning □□□□□□□□□□□ persons precepts as the Teachings of worldlings and those of the Two Vehicles □□□ those who are fully endowed with ten kinds of evils arouse the mind to enlightenment, should first learn the emptiness, and from the emptiness to arise the existence contemplation □□□□□□□□□ □□□□□ Buddha and bodhisattva also should obtain □□ one, as expounded in the "Chapter on Brahma Practice" of the *Flower Garland Sūtra*, the method of contemplating the emptiness is clarified in regards to the following ten aspects: 1. body; 2. bodily activities; 3. intention; 4. intentional activities; 5. mouth; 6. oral activities; 7. Buddha; 8. Dharma; 9. Sangha; 10. emptiness of the precepts.[5] As expounded in the *Mahāyāna Sūtra* [one should] understand all the Teachingss as illusion, as flames, as moon in water, as vacancy, as echo, as the town Ganjambha[6], as dream, as shadow, as in the mirror, as transformation, □□□□□□□□ even □□□□□□ are all entirely the emptiness clarified in the scriptures and treatises of the Great Vehicle.

21 明世間十種惡具足人諸衆生淺深分齊。何以故？爲破我見增上慢謗人謗法邪三業等種種惡故。 第

22 一明□□□□□□□□□□□□□□□□□□□□□因爲□□□□□□□有三段：一以常因收常果。一以

23 □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□如《楞伽經》說；二以常果收

24 □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□因成果就乳酪提胡喻

25 □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□說一二

26 □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

27 □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□爲異世。何以故？□□□ □

28 □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□乘藏作善者□□□□□□

29 □□□□□□□□□□□□□□□□□□佛□□徒鬼徒日□□□□□□□以量喻善惡□□□□□□

30 □□□□□□□□□□□□□□遍法界如《十輪經》說□□□□□□□ 出家人作佛想一明□□□□

31 □□□□□□□□□□□□□□□明於出家□□爲成大□；第四明□□衆生內有人行佛法□□□ □

32 □□□□□□□□□□□□□□□佛佛時□等等種種行□□□□□□□□作經□□□□□□□

33 衆皆作菩薩□□□□□□□□□□衆內教類□□作菩薩行□□□□□□□□於一□□□□□□□

34 成善；第五明一切衆生內有行□是佛盡□□□□□□六者□□□□□□□□種所佛□□□□□□

2.2. The second part clarifies the depth and difference of the sentient beings of the mundane persons who are fully endowed with ten kinds of evils. Why? Because for the sake of breaking the self-view, overweening pride, slandering the other people, slandering the dharma and the three wrong activities as well as the various kinds of evils.

[2.2.1.] Clarifying □□□□□□□□□□□□□□□□□□□□□□□ □ cause is □□□□□□□are three parts:
[2.2.1.1.] By means of permanent causes to harvest the permanent results. First by means of □□□□□□□□□□□□□□□□□□□ □□□□□□□□□□□□□□□as expounded in the *Sūtra on [the Buddha's] Entering [the Country of] Lanka.*
[2.2.1.2.] By means of permanent results to harvest □□□□□□□□ □□□□□□□□□□□□□□□□□□□□□□□□□□□causes accomplish the results in regards to the parable of cheese and purified butter[7] □□□□□□□□□□□□□□□□□□□□□□□□□□ □□□□□□□□□□□□□□saying one and two □□□□□□□□□□□□□□□□□□□□

35 佛四年等智慧佛後二佛同是一見佛□□□□□□□說明佛□□□□□□有同名異名同名異名佛□

36 十方大地皆作微塵多少一種；三者如□□□□□□□□□□□一明如來大慈多少。能與一切衆生世明

37 出世間樂盡；二明如來大悲多少，能代一切惡盡；一切地獄苦盡，一切畜生苦盡，一切餓鬼苦盡，一切人天莫

38 問凡聖，所有苦事悉代受盡，如《大般涅槃經》、《華嚴經》中說；三明如來解法多少。善男子，如來說法不可聽盡，能於

39 一時普爲十方衆生說法。若一劫，百千萬億劫，無量阿僧祇劫，作如是說，一切衆生無有能知如來說法邊際本

40 末。假使無量衆生一時問難，而如來於一念中，各隨其類一音能答，然如來辨才無有窮盡；四明如來禪定多少。

41 如來有無量阿僧祇禪定三昧之所行處。善男子，假使一切衆生皆得十住，各各皆入無量三昧，於百千劫中各

42 人異定，如是經無量劫，猶不能盡知如來三昧境界； 五明如來修身多少。 如來又作無量阿僧祇應身，令一切衆

[2.2.5.1.][8] □□□□□ kinds place Buddha □□□□□□ Buddha four years etc. wisdom Buddha the later two Buddhas are samely one seeing Buddha □□□□□□□ expounding and clarifying Buddha □□

[2.2.5.2.] □□□□ have same names and differently names the same named and differently named Buddhas □ the ten directions of the earth all as tiny particles of dust more or less one kind

[2.2.5.3.] As □□□□□□□□□□□

2.2.5.3.1. Clarifying the amount of Tathāgata's great compassion. [Tathāgata] can with all the sentient beings and worlds clarify the transmundane happiness exhaustively;

2.2.5.3.2. Clarifying the amount of Tathāgata's great sympathy. [Tathāgata] can [bear] in substitution all evils exhaustively, all sufferings of the [path of] hell exhaustively, all sufferings of the [path of] animals exhaustively, all sufferings of the [path of] hungry ghosts exhaustively. All human beings and heavenly beings whether they are worldlings or sages, all their sufferings [Tathāgata] completely bear in substitution exhaustively, as expounded in the *Great Parinirvā□a Sūtra* and the *Flower Garland Sūtra*;

2.2.5.3.3. Clarifying the amount of Tathāgata's comprehesion of the Teachings. "Good sons, Tathāgata's expounding of the Teachings is inexplorable. He can at the one time universally expound the Teachings for the sentient beings from the ten directions. In one eon, in hundreds of millions of eons, and in infinite asa□khyeya eons, one could speaking the following: Of all sentient beings no one can know the limit and bound, beginning and end of Tathāgata's expounding of the Teachings. If innumerable sentient beings ask at the same time, then Tathāgata in one thought, and in accordance with the various kinds [of the sentient beings] answer them with one tone. Thus, Tathāgata's eloquence has no end and limit[9];

2.2.5.3.4. Clarifying the amount of Tathāgata's dhyāna concentration[10]. Tathāgata has places of practice for infinite asa□khyeya dhyāna concentration samādhi. Good sons, if all the sentient beings obtain the Ten Abidings[11], respectively enter the infinite samādhi, and in hundreds thousands eons meditate individually, thus after innumerable eons, they still can not completely know Tathāgata's realm of samādhi.

2.2.5.3.5. Clarifying the amount of Tathāgata's cultivating body. Tathāgata showed further infinite asa□khyeya response-bodies, and caused all sentient beings who should be given and taught [with the Teachings], to see Tathāgata's appearance entirely before them, at the

43 生應受化者，悉見如來皆現其前，於一念頃一一色相皆生信解各有差別。如來又復一時皆現其前，隨其所應

44 而爲說法，令諸衆生悉皆受行；六明如來天眼所見境界非肉眼所見。如來天眼所見境界無量無邊，如來於一

45 念中悉皆見之，如觀掌中阿摩勒果；七明如來□□□□多。如來天耳所聞境界無量無邊，如上天眼，所見境界一

46 切衆生異類音聲，隨其大小於一念頃悉分別知；□□□□□□□□□□如來復有無量無邊無碍智慧，無與等

47 者不可爲譬，一切衆生若心合知，隨其根性種種差別，如來於一刹那頃悉分別知；隨彼衆生各各所念各各所

48 作，隨造善惡所得業報，如來能於三達無礙智慧，於刹那頃悉分別知之；八明如來所有定心多少。善男子，如來常

49 在禪定。何以故？如來終無忘念；九明□□□□□善男子善女人，心不錯亂，不錯亂故思惟如來有大威德，深生殷

50 重信樂之心。七日七夜著鮮淨衣服，恭敬供養，專念如來大功德寶，心不移易必得見佛。若不滿七日乃至一日一

51 夜，命終之時亦得見佛。四者如諸□□□□□□□□□□□□□□□□□□□□□□□□□□成大乘諸經說三

moment of one thought all forms and appearances were believed and understood one by one with respectively differences. Tathāgata showed himself further once entirely before them, and expounded the Teachings in accord with what they were deserved, and caused all sentient beings completely to receive and practice [the Teachings];

2.2.5.3.6. Clarifying the realms that Tathāgata saw with his heavenly eyes are invisible with the flesh eyes [of human being]. The realms that Tathāgata saw with his heavenly eyes are infinite and limitless. Tathāgata saw them all completely in one thought, as he watched a āmala fruit[12] in his palm;

2.2.5.3.7. Clarifying Tathāgata □□□□ much. The realms that Tathāgata heard with his heavenly ears are infinite and limitless, like his superior heavenly eyes, in the realm that he saw all the sentient beings and various kinds of sounds and tones, correspondingly with their strength, he knew them all respectively at the moment of one thought; □□□□□□□□□ Tathāgata further has infinite, limitless and unobstructed wisdom, which has no counterpart and incomparable, beings as if mentally united with all sentient, corresponding to their capacity and nature and various differences. Tathāgata knew them all respectively at an instant; Corresponding to the respective thoughts and respective deeds of the sentient beings, corresponding to their good and evil deeds and the deserved karmic retributions, Tathāgata could know them all respectively at an instant by means of his three-achieving unobstructed wisdom;

2.2.5.3.8. Clarifying the amount of Tathāgata's mind of concentration. Good Sons, Tathāgata had permanently been in dhyāna concentration. Why? Tathāgata had no thought of forgetting after all;

2.2.5.3.9. Clarifying □□□□□ good sons and good women, their minds were not deranged, and because not deranged [they] thought on that Tathāgata had great power and virtue, and arose the minds of respectful and joyful faith deeply. [They] wore fresh and clean clothes for seven days and seven nights, respectfully offering and sustaining, concentrating on thinking on Tathāgata's great treasure of merits and virtues, and their minds did not move and change, and must be able to see the Buddha. If not full seven days but even[13] one day and one night, they were also able to see the Buddha at the end of the life[14].

2.2.5.4. As the □□□□□□□□□□□□□□□□□□□□□□□□□ □□□ accomplishing the scriptures of the Great Vehicles expounding thirdly □□□□ treatises expounding; fourthly as expounded in the *Jewel Cloud Sūtra*, either

52 □□□□論說四如《寶雲經》說若華若□□□□□□□□□□□□□□□□□□□三夜有□行供養福田供事

53 □□□□皆作盡虛空遍法界想。　第三段明世間十種惡具人敬法淺深分齊。何以故? □□□□ □□□爲破我見

54 增上慢人謗法邪三業等種種惡故。□□□□□□□□□□□□□□□□□□□一爲之，人作惡大小皆得有是

55 □□。上說明知能說之教亦皆得有是佛教義，□□□□□□□□□一者儒教说。儒教为衆生善惡作儒教，所以儒教亦是

56 佛教；二者道教說。道教所爲衆生善惡作道教，□□□□□□□□□□□□□□□□□。三乘敬教三乘，亦爲衆生善惡，

57 三乘教亦是佛教；四者一乘教說。一乘所爲衆生善惡□□□□□□□□□□□□，一乘教即是佛教。此明敬四階所說法

58 皆作佛法解，亦須敬四階能□師皆作佛師想，作□□□□□□□□□□說。善男子，所有種種異論、咒術、語言、文字

59 皆是佛說，非外道說。又上十種惡具足人敬惡□□□□□□□□□□□□□□□□乘教與佛教等，於內有三階：一

60 者意業。唯教普敬如上。何以故？一由不別惡□□□□□□□□□□□□□；二由不別大乘內小乘，小乘內大乘故，所

flower or □□□□□□□□□□□□□□□ □□□□ three nights if any □ practices offering and sustaining field of merits offering and serving □□□□ all as the thoughts of the completely vacant exptiness prevailing in the dharma realm.

2.3. The third part clarifies the depth and difference of revering the Teachings of the mundane persons who are fully endowed with ten kinds of evils. Why? □□□□□□ Because for the sake of breaking the self-view, overweening pride, slandering the other people, slandering the dharma and the three wrong activities as well as the various kinds of evils.

[2.3.1.] □□□□□□□□□□□□□□□□□□□□□ one doing it, if one does anything evil, either big of small, one will all obtain such □□. The explanation above clarifies knowing that the explicable Teachingss are also all containing the significance of Buddhism, □□ □□□□□□□
2.3.1.1. The doctrine of Confucianism. For the sake of the good and evil of the sentient beings Confucianism becomes Confucianism, so Confucianism is also Buddhism;
2.3.1.2. The doctrine of Taoism. For the sake of the good and evil of the sentient beings Taoism becomes Taoism, □□□□□□□□□□□□ □□□□□;
2.3.1.3. The doctrine of Three Vehicles. The [doctrine of] Three Vehicles teaches respectfully the three Vehicles, also for the sake of the good and evil of the sentient beings, so the [doctrine of] Three Vehicles is also Buddhism;
2.3.1.4. The doctrine of One Vehicles. The [doctrine of] One Vehicle for the sake of [the good and evil of] the sentient beings □□□□□□ □□□□□□, One Vehicle is just Buddhism. That clarifies the revering of all the expounded doctrines of the four stages, and they all should be understood as Buddhist Teachings; also one should revere the capable masters of □ of the four stages, and they should be regarded as Buddhist masters; as □□□□□□□□□□□ expound. Good Sons, all various kinds of different theories, sorceries, languages and words are all the Buddha's expoundings, not that of the heretics.

2.3.2. Further the above persons who are fully endowed with ten evils revere evil □□□□□□□□□□□□□ Vehicle and Buddhism and so on, wherein are three stages:
2.3.2.1. Intentional Actions. Just to teach to revere universally as [expounded]above. Why? First beause not differentiating the evil

61 以唯合普敬。如《大方廣十輪經》說。二者口業。□□□□□□□□□□□佛教、道教、大乘、小乘、福智三寶，唯

62 除見人作五逆等罪，對面呵勸捨身不犯或□□□□□□□□□□□□者亦不犯； 三者身業。不得共贊說

63 持戒、破戒、空有、佛教、道教、大乘、小乘、智三寶□□□□□□□□□□□聖人謗法人同律，乃至儒教、道教、

64 執著小乘三藏學者亦不得共住，如《法華經》□□□□□□□□□□□□□經》等諸經廣說。 又上敬人重法

65 經中亦具出能敬人所得利益多少分齊，□□□□□□□□□□□□□於法界行自然具足，三乃至得大

66 涅槃果。 第四段明世間十種惡具足人自見已惡多少及離惡成善淺深分齊。何以故？爲破我見增上慢謗人

67 謗法邪三業等種種惡故。 第一明世間十種惡具足人□□□□□□□□自見惡見他善淺深分齊。何以故？爲破我

68 見增上慢謗人謗法邪三業等種種惡故。一者如左□□□□□□□□□□□□□□□□明自見惡見他善；二者如

□□□□□□□□□□□□□□; second because not differentiating the Small Vehicle inside the Great Vehicle and the Great Vehicle inside the Small Vehicle. So just accordingly revere univerally, as expounded in the *Great Corrective and Extensive Ten Wheels Sūtra*;

2.3.2.2. Oral Actions. □□□□□□□□□□□ Buddhism, Taoism, the Great Vehicle, the Small Vehicle, the Three Treasures of meritorious wisdoms, only except seeing others committing the Five Heinous Crimes etc, directly shouting and persuading and sacrificing oneself not violating or □□□□□□□□□□□□□ persons also not violating.

2.3.2.3. Bodily Actions. Together praising and speaking is forbidden, observing precepts, breaking precepts, emptiness and existence, Buddhism, Taoism, the Great Vehicle, the Small Vehicle, the Three Treasures of wisdom □□□□□□□□□□□ the sages slandering the Teachings persons the same precepts, and even one is also not allowed to live together with the learners of Confucianism, Taoism, and those who stick to the canons of the Small Vehicle, as in the *Lotus Sūtra* □□□□□□□□□□□□□ *Sūtra* and all other scriptures extensively expounded.

2.3.3. Further about the above revering the people and respecting the Teachings it is also stated completely in the scriptures concerning the amount and difference of the rewarded benefits if one can revere the people, □□□□□□□□□□□□□ in the dharma realm practice naturely and completely; thirdly even achieving the result of great nirvā□a.

2.4. The fourth part clarifies the depth and difference of seeing themselves their amount of the evils and severing the evil to achieve the good practice of the mundane persons who are fully endowed with ten kinds of evils. Why? Because for the sake of breaking the self-view, overweening pride, slandering the other people, slandering the dharma and the three wrong activities as well as the various kinds of evils.

2.4.1. The first clarifies the depth and difference of seeing themselves their own evils and seeing others' goods □□□□□□□□ the mundane persons who are fully endowed with ten kinds of evils. Why? Because for the sake of breaking the self-view, overweening pride, slandering the other people, slandering the dharma and the three wrong activities as well as the various kinds of evils.

2.4.1.1. As the left □□□□□□□□□□□□□□□□□ clarifying seeing oneself own

《維

69 摩經》八法內說，教菩薩於惡世界內明菩薩行，如有明□□□□□□□□□所與智。第二明世間十種惡

70 具足人自知已所學法分齊。何以故？爲破我見增上慢謗人謗法邪三業等種種惡故□；三者《大般涅槃經》一部

71 皆是。何以故？此經爲種種顛倒衆生出世於□□□□□□□□□□□□□□□肉眼衆生說法，爲肉眼衆

72 生所說法即是世間十種惡具足人所學法□□□□□□□□□□□□□□□□□□□□□□□人□四

73 者《大方廣十輪經》一部皆是。何以故？從首至末□□□□□□□□□□□□□□□□□□□□ □□□□□□

74 是。何以故？從首至末皆爲天龍夜叉□□□□□□□□□□□□□□□□□□□□□□□□□□ □□□

75 說出家人惡無量者皆法末而□□□□□□□□□□□□□□□□□□□□□□□□□□出家人盡說法。

76 五者《法華經四安樂品》說□□□□□□□□□□□□□□□□□□□□□□□□□經內□皆是。何以故？

77 請於此世界行菩薩□□之□□法□□□□□□□□□□□□□□□□□□□須□《勝鬘經》就解明上

78 下者已是凡夫《法華經》□□□□□□□□□□□□□□□□□□□□□□此等類以可知。何以故？具出世

79 間十種惡具足人□□□□□□□□□□□□□□□□□□□□□□□□□□少自知病多少。 第三明世間十

80 種惡具足人□□□□□□□□□少佛□□法破我見增上慢謗人□□□□種種惡故。 如《大方廣十輪經》說。

81 一□□□□□□□□□□□微薄善□二者第四卷內說善城□□□□□第四卷內說求三乘各得少信心信

evils and seeing others' goods;
2.4.1.2. As expounded in the eight methods of the *Vimalakīrti Sūtra*, that Bodhisattas are taught to clarify the practice of bodhisattva in the evil world, just as clarifying □□□□□□□□□□ given wisdom.

2.4.2. Clarifying the difference of knowing themselves their learned Teachings of the mundane persons who are fully endowed with ten kinds of evils. Why? Because for the sake of breaking the self-view, overweening pride, slandering the other people, slandering the dharma and the three wrong activities as well as the various kinds of evils. □[15]
2.4.2.3. The whole *Great Parinirvā□a Sūtra* is about it. Why? That sūtra is for various kinds of reversed sentient beings to transcend the mundane world in □□□□□□□□□□□□□□□□□ the flesh-eyed sentient beings expounding the Teachings, for the flesh-eyed sentient beings expounding the Teachings is just the Teachings which is learned by the mundane persons who are fully endowed with ten kinds of evils □□□□□□□□□□□□□□□□□□□□□□□□□□ persons □.
[2.4.2.4.] The whole *Great Corrective and Extensive Sūtra of Ten Wheels* is about it. Why? From the beginning to the end □□□□□□□□□□□ □□□□□□□□□□□□□□□□□□□ is. Why? From the beginning to the end all for heavenly beings, dragons, yak□a □□□□□□□□□ □□□□□□□□□□□□□□□□□□□□□□□□□ expounding the left-home persons evil infinite all the Teachings end □□□□□□□□□□ □□□□□□□□□□□□□□□□□ the left-home persons exhaustively expounding the Teachings.
2.4.2.5. It is expounded in the Fouth "Chapter on Peace and Pleasure" of the *Lotus Sūtra* □□□□□□□□□□□□□□□□□□□□□□□ □□□□ in the sūtra □ all about it. Why? Requesting in this world to practise bodhisattva □□ of □□ method □□□□□□□□□□□ □□□□□ □□□□□ must □ the *Śrīmālā Sūtra* in regards to understanding clarifying the superior and inferior already are worldings the *Lotus Sūtra* □□□□□□□□□□□□□□□□□□□ □□□□□ those kinds might know. Why? Completely the transmundane persons who are fully endowed with ten kinds of evils □□□□□□□□□□□□□□□□□□□□□□□□□□□ less oneself knowing the illness the amount.

2.4.3. Clarifying the mundane persons who are fully endowed with ten kinds of evils □□□□□□□□□□ less Buddha □□ the Teachings breaking the self-view, overweening pride, slandering the others □□□□[16] and various kinds of evils. As expounded in the *Great Corrective and Extensive Sūtra of Ten Wheels.*

82 了□信□□□□□□□□說亦於三乘各得少信心信此不信□□□□□少智黑暗力故；五者第六卷內說微

83 □□□□□第四明世间十種惡具足人自知已邪解多少。何以故? □□□慢謗人謗法邪三業等種種惡

84 故。□□□□□□□□□經》說，於十二部經內增加人情至□□□□□在者唯知舍慧又複舍判邪說者多由

85 說□□□□□□□□者說。一自言盡知佛法；二出諸經中相□□□□□□法中□疑不信；四自少所知非也

86 □□□□養□□□說法佛言：此人當墮地獄不至涅槃；六□□□□□□□□明是非不順從法化身□□□

87 □□□□□□□□無教及者法墮地獄人如來悉知我諸□□□□□□□一種□緣種□□□□□□ □□

88 □□□□□□□□說。善男子，善女人，樂著讀誦求菩提者便有嫉妬求名利富貴高心。自是輕慢毀他。以自

89 高故，尚不能得欲界善根，何況能得色□世界一切爲□□□□□□□□□□□□□□□佛道及無上菩提果

90 □□□□□□□□□第一義。 四者如《大方廣十輪經》說一□□□□□□□□□□□□□□□ □□

91 □□□□□□□□現爲智慧□□□□□□說後世乃至能□□□□□□謗阿蘭若□□□□□□

92 □□□□□□□□。何以故？此段上下所明皆用多聞智慧作□□□□□□□聲聞乘得少信心諸已聽於

93 □□□□□□□大乘法誹謗不信不讀不誦下至一得生□□□□□□□□複有人信辟支佛法及大乘法

94 而不信於聲聞 百毀譏訶亦名誹謗正法是名誹謗正法□□□□□□□入正道彼於無量衆生法眼。第

2.4.3.1. □□□□□□□□□□□ tiny and meagre good □
2.4.3.2. In the fourth scroll it is expounded that the good town □□□□□ in the fourth scroll it is expounded seeking the Three Vehicles obtaining respectly the less belief, mind belief, understanding □ belief □□□□□□□□ expounded also in the three Vehicles obtaining respectly the less belief mind belief knowing □ belief □□□□□□□□expounding also from the Three Vehicles respectively obtaining less belief mind belief those non-belief □□□□□ less wisdom and the darkness power because.[17]
2.4.3.5. In the 6th scroll it is expounded the tiny □□□□

2.4.4. Clarifying the amount of knowing themselves their evil understanding of mundane persons who are fully endowed with ten kinds of evils. Why? □□□ overweening pride, slandering the other people, slandering the dharma and the three wrong activities as well as the various kinds of evils. □□□□□□□□□ *Sutra* expounds, in the Twelve Divisions of Buddhis Canon accumulated the human feelings until □□□□□ in persons who only know abandoning wisdom and further abandon judging speaking persons much from speaking □□□ □□□□□ persons speaking.
2.4.4.1. One claims oneself knowing Buddha's Teachings completely;
2.4.4.2. Out of the scriptures the attributes□□□□
2.4.4.3. □□ in the Teachings □ doubt and not believing;
2.4.4.4. Oneself less knowing non □□□□ sustaining;
2.4.4.5. □□□ expounding the Teachings Buddha said: "that that man must fall into the hell and will not reach to the nirvā□a";
2.4.4.6. □□□□□□□□ clarifying the correctness and faulty not in accord with the Teachings transformed body □□□□□□□□□ □□ not instructed and the persons the Teachings fall into the hell human beings Tathāgata entirely knew my all □□□□□□□ one kind □ conditions kind □□□□□□□□□□□□□□□□□ expounded.
Good Sons, good women, If one seeks the bodhi through enjoying reading and reciting, one will have the lofty mind of jealousy, persuing fame, benifits, wealth and nobleness. Thus one will contempt and belittle others. Because of the arrogance one can not obtain the good roots of the Desire Realm, How can he obtain the Form □ world all for □□□□□□□□□□□□□□□□ the Buddha Way and the highest result of Bodhi □□□□□□□□□ the first significance.
Fourthly[18] as expounded in the *Great Collective and Extensive Sūtra of Ten Wheels*, one □□□□□□□□□□□□□□□□□□□□□□□□□□□ □ shown as

95 五明持戒多聞智慧能關雖行利益無量□□亦不免滅三乘□□□□□□□□□□□道亦名惡福因□止

96 無□僧於□□□所人□□是可□上□□大海亦名不成□□□□□□□□□□稱佛是我世尊□□

97 度後得信向□□僧聖戒身不起惡□□而不譏他惡而廣爲人□□□□□□□□□□□□□□□□□ □□

98 從回能無量□□諸罪作□是信令作九十五種異學外道猶□□□□□□□□□□□□□□□□□□ □□

99 及□不。明持戒多聞智慧滅三乘三寶盡。一贊毀持戒破戒二種比丘□□□□□□□□□□□□□ □□

100 □□發福智□華□□第三段□三乘真善人等三乘三寶盡皆悉□□□□□□□□□□□□□□□□ □□

101 明□□戒惡行比丘義□□□□□□七複重說結上種種惡□□□□□□□□於三乘不成法□□□□ □

102 □□□□□□□至大乘亦□□□□□□持而生誹謗霜鄣不□□□□□□□□得少聞者於諸聲聞□

103 □□□□□□□□□□□□□□□不信我與大乘及能□□□□□□□我德大乘不受聲聞說故是

104 □□□□□□□□□□□□□□□□丘一切衆生□□□□□□□□□紹三寶種使不斷絕出家修

105 □□□□□□□□□□□□□□□□三乘　明由□□□□□□□□福田所以滅三乘三寶盡從

106 □□□□□□□□□□□□□□□□一十皆用多聞智慧□□□□□□□多聞智慧起惡滅佛法墮三

107 □□□□□□□□□□□□□□□□□十種惡具足人□□□□□□□□世界惡如下段若有能公斷名
108 □□□□□□□□□□□□□□□□□□□出世故□□□□□□□□□□□複□□惡言諸經說我大
109 □□□□□□□□□□□□□□□□□□□法亦□□□□□□□□□□□□□□有耶□爲昔明耶
110 □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□於大乘經內
111 從□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□或有得法不盡錯五於

112 大乘□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□具足人身知已種種惡多少
113 何以故□□□□□□□□□□□□□□□□□□□□□□□□□□□□□明惡衆生等與流轉生死受身

wisdom □□□□□□ expounding the after worlds and even can □□□□□□slandering ara□ya[19] □□□□□□□□□□□ □□□ Why?
In this part above and below the clarification all using widely learning and wisdom as □□□□□□□ the Vehicle of Voice-hearers obtaining less belief mind those already listened in □□□□□□□ the Great Vehicle Teachings slandering not believing not reading not reciting down to obtaining one birth □□□□□□□□ further if any believes in the Teachings of pratyekabuddha[20] and the Teachings of the Great Vehicle, but does not believes in [the Vehicle of] Voice-hearers, much damaging and blaming them also called slandering the correct Teachings, thus called slandering the correct Teachings □□□□□ □□ entering the correct path then to the infinite sentient beings dharma-eyes.

2.4.5. Clarifying that keeping the precepts, widely learning and wisdom can close though practising benefits infinite □□ also not exepted and reduced the Three Vehicles □□□□□□□□□□□way also called evil merits cause □ stop no □ monks from □□□ place man □□ is able to □ above □□ great see also called not accomplishing □□□ □□□□□□□ called Buddha is my World Honored One □□ nirvā□a after obtain the belief to □□ monks sages precepts the body not arising evil □□ but not criticizing others' evil but extensively for the people □□□□□□□□□□□□□□□□□□□ from back can infinitely □□ the sins as □ such belief cause the ninty-five kinds of heterodoxies and heretics still □□□□□□□□□□□□□□□□ □□□□□ and □ not.
Clarifying that charity, keeping precepts, widely learning and wisdom destroying the Three Vehicles and the Three Treasures exhaustively. First praising and blaming the two kinds of bhik□us who keep the precepts or break the precepts □□□□□□□□□□□□□□□ □□ arouse the merits and wisdom □ flower □□the third part □ the three Vehicles the true good men etc. the Three Vehicles and Three Treasures exhaustively all entirely □□□□□□□□□□□ □□□□□□□
Clarifying □□ precepts the evil practice bhik□us significance □□□□□□ seven further repeat and conclude the above various kinds of evils □□□□□□□□ from the three Vehicles not accomplisching the Teachings □□□□□□□□□□□□ to the Great Vehicle also □□□□□□ hold and arise the slander frost hindrance not □□□□□□□□ obtain less listening to the direct disciples □□□□□□□□□□□□□□□□□ not believe me and the Great Vehicle and can □□□□□□□ my virtue the Great Vehicle and do not accept the expoundings of the voice-hearers therefore such □□□□□□□□□□□□□□□□□ bhik□us and all sentient beings

114 多少或盡地□□□□□□□□□□□□□□□□□□□□□□□□□□□□生死無量不可得盡或明經

115 欲多少一□□□□□□□□□□□□□□□□□□□□□□□□□□□□行盡如上說□二者如《大方

116 等陀羅尼》□□□□□□□□□□□□□□□教大地主□□□□□□□□□從微塵一點乃至一切衆生

117 及法性一種□三乘□□□□□□□□□□□□行出家人得□□□□□說；二明不□學上□□□於內
118 有三階：一明聲聞人□□□□□□□□□□□□□□□□□□□□□□□□如罰出家人而治罰出家

119 □□□明治罰出家人□□□□□□□□□□□□無邊□□□□□□□□蜜菩薩口內說十方世界所

120 有謗毀賢聖者皆爲□□□□□□□□□□□□□□□□□□□□□□□無戒破戒兩種比丘得罪多少
121 如下說；二明佛滅度後破戒比丘□□□□□□□□□□□□□□□□□□□各犯百千萬億唯與破戒比

122 丘一日一夜受他供養罪一種。又明□□□□□□□□□□□即□□□□□□法輕重如下說假使百千万

123 億諸佛三輪示現不能令悟使得□業人□□□□□□□□聞法□□□□□□□滅法多少如上說。又明不

124 淨說法得罪多少過於煞三千大千世界滿中众生。□明我見以僧□□□□□□又明謗人謗法受罪鄣之時

125 節多少，於八大地獄一一地獄內各滿三十六所□□□□□□□□□□□□□地獄出三百身，常從生而盲

126 又得出家於一佛所十萬億歲勤行精進如救頭然罪障不盡還□□□□□□□□值九十九億佛不得億九。

127 第六明世間十種惡具足人自知已打縛煞害出家人等得罪多少。何以故？爲破我見增上慢謗人謗法邪三業

□□□□□□□□□□ continue the Three Treasures seeds cause them not to stop and extinguish leaving home cultivate □□□□□□□□□□□□□□□□□ the Three Vehicles.
Clarifying from □□□□□□□□ fields of merits therefore destroying the Three Vehicles and the Three Treasures exhaustively from □□□□□□□□□□□□□□□□□□ one ten all using widely learning and wisdom □□□□□□□ widely learning and wisdom arising the evil destroying the Teachings falling into the three □□□□□□□□□□□□□□□□□□ human beings endowed with ten kinds of evils □□□□□□□□ the world evil as the following part if any can judge fairly called □□□□□□□□□□□ □□□□□□□□□ transmigrating the world therefore □□□□□ □□□□□□ further □□ the evil speech the scriptures expounding my great □□□□□□□□□□□□□□□□□□□□□□ the Teachings also □□□□□□□□□□□□□□ there are □ for in the past clarifying □ □□□□□□□□□□□□□□□□□□□□ □□□□□□□□□□□□□□in scriptures of the Great Vehicle from □□□□□□□□□□□□□□□□□□□□□□□□□□□□ □□□□□ if any obtains the dharma not exhaustively wrong fifthly in the Great Vehicle □□□□□□□□□□□□□□□□□□□□ □□□□□□□□□ fully endowed persons knowing the amount of their own various kinds of evils. Why? □□□□□□□□□□□□ □□□□□□□□□□□□□□□□ clarifying the evil sentient beings etc. and the continuity of birth and death accepted body the amount or the end place □□□ □□□□□□□□□□□□□□□□□□□□ □□□□□ the birth and death infinite can not be obtained exhaustively or clarifying the scriptures the desire more or less.
First □□□□□□□□□□□□□□□□□□□□□□□□□□□□□ □ practice exhaustively as expounded above □ second as the *Great Corrective and Extensive Dhāra□ī Sūtra* □□□□□□□□□□□□ teachings the great land lord □□□□□□□□□ from one tiny dust and even to all sentient beings as well as the nature of the Teachings one kind □ the Three Vehicles □□□□□□□□□□ practice the left-home people obtaining □□□□□ expound. Second clarifying not □ learning superior □□□ wherein are three stages: First clarifying the direct disciples □□□□□□□□□□□□□□ □□□□□□□□□ if penalizing the left-home people and punishing the left-home □□□ clarifying punishing the left-home people □□ □□□□□□□□□□ without limit □□□□□□□□ pāramitā bodhisattva mouth saying the ten directions worlds all those who slander and damage the sages are all □□□□□□□□□□□□□ □□□□□□□□□□ no precepts or breaking the precepts the two kinds bhik□us obtaining demerits the amount as following: Second clarifying after Buddha’s nirvā□a the bhik□us who have broken

128 等種種惡故。 一者如《大集月藏分經》說明佛滅度後惡衆生等於三寶內□□得罪多少。 一明打罵系縛无

129 戒破戒兩種比丘者，則壞三世諸佛法身報身，則挑一切天人眼目； 二明打罵系縛無戒破戒兩種比丘者，得

130 罪過於出一万億佛身血。何以故？出佛身血不能滅佛入一切衆生涅槃果□，亦不能滅國土，所以得罪輕。打罵

131 系縛無戒破戒比丘兩種比丘，一能滅自身涅槃果，二能滅一切衆生涅槃果，□□□所以得罪重； 三明佛滅

132 度一千五百年已後，於破戒比丘邊作善惡得罪得福與佛等。何以故？佛□□□比丘同住不退地故。何以故？惡

133 衆生與惡時惡世界惡福田有緣，會由得四種惡具足，始能滅涅槃善果□□□□緣亦如是，或由各望有緣衆

134 生說，所以佛與破戒比丘得有生罪生福等義，如經說除有緣衆生□□□□□□□此文驗所以知。 二者如

135 《大方廣十輪經》說明五濁惡世界佛滅度後惡衆生等於三寶□□□□□□□。一者日別煞蟲五萬斛至滿

the precepts □□□□□□□□□□□□□□□□□□□ repectly committing thousands of millions of only with the bhik□us who have broken the precepts one day and one night receiving his offering and sustaining sin one kind.
Further clarifying □□□□□□□□□□□ just □□□□□□ Teachings light and heavy as expounded below if thousands of millions of Buddhas with three wheels showing can not cause enlightened make obtain □ actions persons □□□□□□□□ hearing the Teachings □□□□□□□ destroying the Teachings more or less as expounded above.
Further clarifying the amount of obtaining demerits by the impure teachings, which are more than killing the sentient beings of the full three thousand great chiliocosms. □ clarifying the self-view with the monks □□□□□□ Further clarifying the amount of the time of receiving the demerits from slandering other people and slandering the Teachings, in the Eight Great Hells each hell respectly fulfilling thirty-six places □□□□□□□□□□ □□□ hells coming out three hundreds bodies, permanently blind with the birth and further leaving home to one Buddha place for ten trillion years diligently practise the efforts as if to save the head but the hindrance of crimes not exhausted still □□□□□□□□ meeting ninty-nine hundred million Buddhas not obtaining hundred million nine

2.4.6. Clarifying the amount of obtained demerits for mundane persons who are fully endowed with ten kinds of evils knowing themselves beating, banding, killing and murdering the left-home persons. Why? Because for the sake of breaking the self-view, overweening pride, slandering the other people, slandering the dharma and the three wrong activities as well as the various kinds of evils.
2.4.6.1. As expounded in the “Chapter on Moon Storehouse” of the *Great Collection Sūtra*, clarifying after Buddha’s nirvā□a the amount of obtained demerits inside the Three Treasures □□ for the evil sentient beings etc.
2.4.6.1.1. Clarifying those who beat, condemn, ligate and band the two kinds of *bhik□us* with no precepts and breaking the precepts, will ruin the dharma-bodies and reward-bodies of all Buddhas from the Three Times, and will provoke the eyes of all heavenly beings and human beings;
2.4.6.1.2. Clarifying those who beat, condemn, ligate and band the two kinds of *bhik□us* with no precepts and breaking the precepts, obtain demerits more than making trillion Buddhas’ bodies bleeding. Why?

136 千歲，唯與淫女舍一日一夜罪等； 二者日別煞蟲五十萬斛至滿千歲，唯與酒家舍一日一夜罪等； 三者日

137 日別煞蟲五百萬斛至千歲，唯與屠兒舍一日一夜罪等；□□□□□□煞蟲□□□至萬千歲，唯與奪佛物法

138 物僧物一日一夜罪等； 五者日別煞蟲五千萬斛至滿千歲，□□□□□□□□□一日一夜罪等，乃至煞出

139 家人亦或是； 六者日別煞蟲五千萬斛至滿千歲，唯與說三乘□□□□□□□□罪等。人人於上所明罪多

140 少，內有三： 一以初類後；二以後類前；三明驗罪多多各各身□□□□□□□□。第七明世間十種惡具足人自

141 知已破戒□多少。何以故？爲破我見增上慢謗人謗法邪三業等種種惡故。一者□□如《大集月藏分經》說，明如來

142 滅度至千□□□□□无戒破戒兩種比丘在； 二者如《佛藏經》中說，明□□□□□□□比丘□□□□□第八

143 明世間十種惡具足人自知已煩惱輕重。何以故？爲破我見增上慢謗人謗法邪三業□□□一種□□一者如《迦

144 葉經》說，明如來一千五百歲以後□□佛住世神通示現說法，故□□□□□□□□□□□□□ □□□□

Making Buddha's body bleeding can not destroy the Buddha's result of entering nirvā□a □ for all sentient beings, can also not destroy the territory, so the obtained demerits is light. Beating, condemning, ligating and banding the two kinds of *bhik□us* with no precepts and breaking the precepts, first it can destroy the nirvā□a result of oneself; second it can destroy the nirvā□a result of all sentient beings, □□□ so the obtained demerits is grave;

2.4.6.1.3. Clarifying one thousand and five hundred years after Buddha's nirvā□a, one obtains demerits or merits by the *bhik□us* who breakthe precepts as much as by the Buddhas. Why? Because Buddha □□□ *bhik□us* together abiding in the place of non-withdraw. Why? The evil sentient beings have conditions with the evil time, evil world and evil fields of merits, thus they obtain the four kinds of evil full endowments, beginning to be able to destroy the good results of nirvā□a □□□□ conditions also the same, or said by the desired and conditioned sentient beings, therefore by the Buddha or the *bhik□us* who break the precepts obtaining the equal significance from the aroused demerits and merits, as expounded in the scriptures except the conditioned sentient beings □□□□□□□ this text confirmed thus knowing.

2.4.6.2. As expounded in the *Great Extensive and Collective Sūtra of Ten Wheels*, clarifying the evil world of the five defilements after Buddha's nirvā□a the evil sentient beings etc. to the Three Treasures □□□□ □□□□

2.4.6.2.1. Everyday cutting and killing insects[21] fifty thousands *hu*[22] until full thousand years, [such demerits] are just equal to the demerits of residing with licentious woman for one day and one night;

2.4.6.2.2. Everyday cutting and killing insects five hundred thousands *hu* until full thousand years, [such demerits] are just equal to the demerits of residing with winehouse for one day and one night;

2.4.6.2.3. Day after day cutting and killing insects five million *hu* until one thousand years, [such demerits] are just equal to the demerits of residing with slaughter man for one day and one night;

2.4.6.2.4. Everyday cutting and killing insects □□□ until ten thousand years, [such demerits] are just equal to the demerits of robbing belongings of Buddha, belongings of the Teachings and belongings of the monls for one day and one night;

2.4.6.2.5. Everyday cutting and killing insects fifty million *hu* until full thousand years, □□□□□□□□ for one day and one night, and even killing the left-home persons is also so;

145 《佛藏經》說此或謗人謗法內偏重者□□□□□百千萬億諸佛三輪示現□□□□□□□□□□□ □□□□

146 深諳十二因緣七漏十想乃至一一大乘經內但使明惡盡虛空□□□□□□□□□□□□□□□□□ □

147 □□□□□□此義推明世間十種惡具足人自知已是當佛滅度五□□□□□□□□□□□□□□□ □□

148 □□□人自知已是當佛滅度後二千年後人唯合千千萬萬怖死唯□□□□□□□□□□□□□□□ □□

149 □□名字，或名阿闡提，如《大般涅槃經》說；或名旃陀羅，或名驢封子，如《大□□□□□□ □□□□□□□□□□

150 若□旃陀羅，或名自稱菩薩而行狗法，或名野幹鳴，如《迦叶經》所說，或名聲□□□□□□□ □□□□□□□□

151 子，如《大集月藏分經》說，《大方廣十輪經》亦如是，處處皆道由打罵系縛我□□□□□□□ □□□□□□□□□

152 第九明世間十種惡具足人不令受身及作種種主。何以故？爲破我見增上慢謗人謗法邪三業等種種惡故。上

153 人語下經文： 爾時複有大士聰明智慧，從坐而起合掌叉手而發誓言：我等雖在生死，不得法忍已來，於其中間願

154 莫受身。莫作輔相大臣，乃至令長村邑聚落等主，不作國師軍幢將師長宿之處，不作祠祀主估客商人處，不作

2.4.6.2.6. Everyday cutting and killing insects fifty million *hu* until full thousand years, [such demerits] are just expounding the Three Vehicles □□□□□□□□ the demerits equal 。
Everyone from above clarifying the amount of demerits, wherein are three:
2.4.6.2.6.1. With the beginnig similar to the latter,
2.4.6.2.6.2. With the latter similar to the former,
2.4.6.2.6.3. Clarifying confirming demerits very much, each respectively body □□□□□□□□

2.4.7. Clarifying the amount of □ for mundane persons who are fully endowed with ten kinds of evils knowing themselves breaking the precepts. Why? Because for the sake of breaking the self-view, overweening pride, slandering the other people, slandering the dharma and the three wrong activities as well as the various kinds of evils.
2.4.7.1. □□ as expounded in the “Chapter on Moon Storehouse” of the *Great Collection Sūtra*, clarifying after Buddha’s nirvā□a until thousand □□□□□ the two kinds of *bhik□us* with no and breaking the the preceptes in;
2.4.7.2. As expounden in the *Buddha Storehouse Sūtra*, clarifying □□□□□□□ *bhik□us* □□□□□

2.4.8. Clarifying the weight for mundane persons who are fully endowed with ten kinds of evils knowing themselves their afflications. Why? Because for the sake of breaking the self-view, overweening pride, slandering the others and slandering the dharma and the three wrong activities □□□ one kind □□
2.4.8.1. As expoounden in the *Kaśyapa Sūtra*, clarifying Tathāgata after one thousand and five hundred years □□ Buddha abiding in the world supernatural power showing and expounding the Teachings, therefore □□□□□□□□□□□□□□□□□□□ expounded in the *Buddha Storehouse Sūtra* thus if any slandering the other people or slandering the Teachings in laying particularly stress persons □□□ □□ hundred thousand trillion Buddhas the Three Wheels showing □□□□□□□□□□□□□□□□ deeply knowing well the Twelve Interconnected Causes and Conditions, Seven Defilements, Ten Thoughts and even to within each scripture of the Great Vehicle just cause to clarify the evil exhaustively and the empty space □□□□□ □□□□□□□□□□□□□□□□□□□□ that significance deducing clarifying for mundane persons who are fully endowed with ten kinds of

155 居士處不作庶人處，不作斷事處，若不得法忍，不於衆生場居自在處。若作是等則於佛法名重因緣，必當墮於阿

156 鼻地獄。 第十明世間十種惡具足人自知已合於僞歸□□□分齊。何以故？爲破我見增上慢謗人謗法邪三

157 業等種種惡故。 《大般涅槃經》、《大方廣十輪經》皆就四種僧教佛滅度□□□□□□□□□人持法法□一者就

158 恒河沙喻，明肉眼顛倒衆生等，免謗人謗法及解義時節令使自知免□□□□□□□□三乘等指人邪法偏求

159 諸佛菩薩等正人正法； 二者就殼銹喻，教肉眼顛倒衆生等，離善惡□□□□□□□□不淨財，或由灭佛法最

160 多，或由一切肉眼衆生皆知分齊可以偏出此，或就行說，或明人開行□□□□□□□□三者就迦羅果鎮頭迦

161 果雪山藥喻，教肉眼顛倒衆生等，離善惡相似，惡多善少惡，餘義如上說□□□□□□□□以□□□□□果善

162 惡俱舍。 四者明肉眼顛倒衆生等，所舍邪人邪法，唯合望聚舍，所謂□□□□□□論□□明文□□乘法略教，或

evils in the world knowing themselves thus after Buddha's nirvā□a five □□□□□□□□□□□□□□□□□□□□ persons knowing themselves two thousand years after Buddha's nirvā□a,
persons only in accord with hundreds of thousands of freightening death only □□□□□□□□□□□□□□□□□□□□ name or called ācchantika[23], as expounded in the *Great Parinirvā□a Sūtra*, or called Ca□□āla[24], or called Lüfengzi[25], as the *Great* □□□□□□□□□ □□□□□□□ if □ Ca□□āla, or called claiming to be bodhisattva but practise the dog method, or called fox crying as expounded in the Kaśyapa Sūtra, or called voice □□□□□□□□□□□□□□□□ son，as expounded in the Chapter of Moon Storehouse of the *Great Collection Sūtra*. The *Great Collective and Extensive Sūtra of Ten Wheels* is also the same, everywhere all saying from beating, condemning, ligating and banding my □□□□□□□□□□□□□□□□

2.4.9. Clarifying mundane persons who are fully endowed with ten kinds of evils not being reborn into a new body and not becoming various kinds of chief. Why? Because for the sake of breaking the self-view, overweening pride, slandering the other people, slandering the dharma and the three wrong activities as well as the various kinds of evils. Above are the human words and below are scriptural texts: "Then further there was a intelligent and wise bodhisattva, who arose from his seat folding his hands together with the fingers crossed and swore his words of a vow: 'Though we were in the [cycle of] birth and death, since not obtaining the dharma patience, in the middle of which we vowed not to be reborn into a new body. Not to be chancellor or minister, even [not to be] commander of a village or settlement etc, not to be the place of a national preceptor, military officer, general or senior, not to be the place of a priest, dealer or merchant, not to be the place of lay people, not to be the place of ordinary people, not to be the place of judging. If we did not obtain the dharma patience, we should not be in the area of the sentient beings or abide in the place of unimpededness. If we would do the above mentioned things, then according to the Teachings it is called heavy causes and conditions, and must be falled into the hell of Avīci".[26]

2.4.10. Clarifying for mundane persons who are fully endowed with ten kinds of evils knowing themselves their in accord with falsely returning □□□ the difference. Why? Because for the sake of breaking the self-view, overweening pride, slandering the other people, slandering the

163 由滅佛法最多，如上邪解及種種惡內說，或由一切肉眼衆生皆知分齊等，□□□□□□□□解說； 五者明肉眼

164 顛倒衆生，所依正人正法，唯合望聚依，所謂諸佛菩薩及《涅槃經》或由□□□□□□□多少□一切肉眼衆生皆知

165 分齊，所以偏出此或亦就解說； 六者複就行明肉眼顛倒衆生等，所依□□□□□□正□分齊，一明人多聽，二佛

166 二菩薩三緣覺四聲聞五人內信方等者，明人无別人以行成人昔□□□□□□□□□□□合依此，不□依五行

167 相當者皆不合依。 一明自離十惡教人離十惡； 二明自修菩提人□□□□□□□□□□□；三明自修行信戒、佈施、

168 多聞、智慧，教人修行信戒、佈施、多聞、智慧； 四明所作之事不求自樂□□□□□□□□□ □□□□；五明見他有過不

169 說其短口常宣說純善之事，乃至法及行亦知如是，如《大般涅槃經》說□□□□□□□□□□□ □□衆生□□□□一

170 向別惡，所謂四重五逆謗聖人謗法十一種根本罪，或由一切罪內□□□□□□□□□□□□□□□ □□□□□□□

171 出； 八者明肉眼真善人等，治罰破戒比丘，犯四重五逆謗聖賢謗法□□□□□□□□□□□□□ □□□□□□□□

dharma and the three wrong activities as well as the various kinds of evils. The *Great Parinirvā□a Sūtra* and the *Great Extensive and Collective Sūtra of Ten Wheels* all concerning the four kinds of monks teachings after Buddha's nirvā□a □□□□□□□□□ persons maintaining the Teachings method □

2.4.10.1. With the parable of the sands of Ganges River, clarifying the reversed sentient beings with flesh eyes and so on, being exempt from slandering the other persons and slandering the Teachings and understanding the significances and seasons causing them knowing themselves to be exempted □□□□□□□□ Three Vehicles and so on indicating people the wrong Teachings being inclined to seek the Buddhas and bodhisattvas etc. the correct persons and correct Teachings.

2.4.10.2. With the parable of husk and rust, instructing the reversed sentient beings with flesh eyes and so on, severing from the good and evil □□□□□□□□ unclean wealth, or from destroying the Teachings at most, or from all sentient beings with flesh eyes all knowing the difference which can be inclined out from that, or expounded as to the practice, or clarifying people beginning to practise □□□□□□□□

2.4.10.3. With the parable of Kālaka fruit and Tinduka fruit[27] and the medicine of snowy mountain, instructung the reversed sentient beings with flesh eyes, severing from the resembled good and evil, the evil of more evil and less good, the other significance as expounded as above □□□□□□□□ with □□□□□ results the good and evil are both abandoned.

2.4.10.4. Clarifying the reversed sentient beings with flesh eyes etc, abandoned the evil person and evil Teachings, just combining desire and gathering and abandoning, that is □□□□□□ treatise □□ clarifying the text □□ Vehicle Teachings abridged instruction, or from destroying the Teachings at most, as the above evil explanation and various kinds of expounding within the evil, or from all sentient beings with flesh eyes entirely knowing the difference etc. □□□□□□□□ explaining and expounding.

2.4.10.5. Clarifying the reversed sentient being with flesh eyes, the relied correct persons and correct Teachings, just combining the desire and gathering and relying, that is the Buddhas and bodhisattvas and the *Nirvā□a Sutra*, or from □□□□□□□ more or less □ all sentient beings with flesh eyes knowing the difference, therefore that is inclined to come forth, or also as to the explaining and expounding.

2.4.10.6. Further with the practice clarifying the reversed sentient beings with flesh eyes etc, the relied □□□□□□ correct □ difference, first

172 若在布薩自恣之時，聽使驅出不共一法事三世僧物飲食敷具皆不聽□□□□□□□□□□□□□ □□□□□□□

173 衆而悉不聽王及大臣加其鞭杖系閉謫罰乃至奪命，又犯十一種根本罪□□□□□□□□□□□□ □□□□□□□

174 儐令出若已有出家諸□□諸不應加其□□□□縛闭又听□□□□□□□□□□□□□□□□□□ □□□□

175 合打罵系縛出家人所□□□後遣肉眼顛倒众生□養□□□□□□□□□□□□□□□□□□□□ □□□□□□

176 和僧還說出家人長短□□持戒□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ □□□□□□

177 而是三乘器第一義僧攝□□□□□□戒□□□□□□□□□□□□□□□□□□□□□□□□□□ □
178 覆藏□□□戒以□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ □
179 □於□□□□□□□□□□□□□□□□持戒以已之惡三□□□□□□□□□□□□□□□□□□ □
180 □□□□□□後一先轉□□□□□□法內亦名死屍是可棄者於□□□□□□□□□□□□□□□□ □
181 □□□世尊我滅度後□□□心□法僧聖戒自不起惡悉百千□□□□□□□□□□□□□□□□□□ □

182 已所作惡數數懺悔能除□□□種種諸罪作如是複令我九□□□□□□□□□□□□□□□□□□□ □

183 □修功德之所能及，如《大方廣十輪經》說□又□《大般涅槃經》□□□□故□□□□□□□□ □□□□□□

184 一□慧眼成就菩薩治罚衆生淺深，或打或煞皆得，或贊毀持戒破戒，或贊毀□□□□□□□□□ □□□□

185 乘□□或贊毀福智皆得，如經內說□□□□仙與國王煞婆羅門等皆漏□□□□□□□□□□□□ □□

186 深，雖不打不煞有畜八不淨財犯重也□□□□□未使□三乘教內服菩薩□□□□□□□□□□□ □□

187 應相似； 九者《大集經月藏分經》內亦□□□□□□□□□擇法□□□□□□□□□□□□□ □□□□

188 者即是《大方廣十輪經》內判一切在家出□□□□□□□□□者是及與□□□□□□□□□□□□□ □□□

189 《大方廣十輪經》內佛開國王大臣助□□□□□□□□□ 上人語下經文： □□□□□□□□□ □□□□□

190 □□十者如其見有於我法中而出家者，作大罪業、大煞生、大偷盜、大妄語、大罪業及餘不善。如是等類但當

clarifying people listening more: first Buddhas, second bodhisattvas, thirdly solitary realizers, fourthly direct disciples, fifthly those who believe in the Buddhism inside the human beings; clarifying no other persons through practice accomplishing people in the last □□□□□□□□□□□ accordingly relying on this, not □ relying on the Five Practices correspondingly all not accordingly relying on.

2.4.10.7.[28]

2.4.10.7.1. [29]Clarifying [the Genuine Teachers] severing themselves from the Ten Evils, and also instructing the other persons severing the Ten Evils;

2.4.10.7.2. [The Genuine Teachers] cultivating the bodhi themselves persons □□□□□□□□□□□

2.4.10.7.3. [The Genuine Teachers] can cultivate and practice themselves faith and morality, charity, learn widely and be of wisdom; and they instruct other persons [to cultivate and practise] faith and morality, charity, learn widely and be of wisdom;

2.4.10.7.4. Clarifying what [they] have done is not attempted for the sake of happiness of themselves, □□□□□□□□□□□□□

2.4.10.7.5. Clarifying seeing other persons having faults, [they] would not criticize their shortcomings, and they always transmit and expound the things of pure good, and even to theTeachings and practice also know in a same way, as expounded in the *Great Parinirvā□a Sūtra* □□□□□□□□□□□□□ sentient beings □□□□ constantly separating from the evil, namely the Four Heavy Sins and the Five Feinous Crimes, slandering the sages, slandering the Teachings, the Eleven Principal Crimes, or from all crimes inside □□□□□□□□□□□ □□□□□□□□□□ out.

2.4.10.8. Clarifying that the true good men etc. with flesh eyes, [if they] punish the bhik□us who have broken the precepts, commit the Four Heavy Sins and the Five Feinous Crimes, slandering the sage and the wise, slandering the Teachings □□□□□□□□□□□□□□□□□ □□□□ if at the time bodhisattva self-indulgence, allowing expelling out not together one services, the belongings of monks of the Three Times, drinks and foods, beddings, all not allowed □□□□□□□□ □□□□□□□□□□□□□ all and completely not allowed.

The king and chancellors exerting their whip and stick [on them], banding and closing, reproaching and punishing, and even killing them, further committing the Eleven Pricipal Crimes □□□□□□ □□□□□□□□□□□□□□ exile ordering out if already left home the □□ all should not be exerted their □□□□ binding, closing and allowing

191 如法儐出國土，出城邑村落，不聽在寺。亦複不得同僧事業，利養之物悉不共同。不得鞭打，若鞭打者理所不應。

192 亦不應口業罵辱，一切不應加其身罪。若故違法而謫罰者，是人便於解脫退落受於下類，遠離一切人天善道，

193 必定歸趣阿鼻地獄，何況鞭打爲佛出家具持戒者□十一者明世間十種惡具足人□□□□□。何以

194 故爲破我見增上慢謗人謗法邪三業等種種惡故□□□□□知犯戒□□□□□□□□□□□□□ □□
195 三寶； 四者不畏不消他信施罰道□□□□□□□□□□□經文殊師利□□□□□□□□□□□ □□□□

196 □二汝等 上比數歸俗； 五者由懺□□□□□□□□□□□□經大□□□□□□□□□□□□ □□□□

197 即論此五種法此經所以知。 第十二明□□□□□□□□□□□已不□□□□□□□□□□□□ □□□□
198 今人論發□□□□□□惡故。 一者明□□□□□□□□□□□□□□□□□□□□□□□□□ □□□□
199 □合□□□□□□□□明□合□求出法人□□□□□□□□□□□□□□□□□□□□□□□□□□ □□□
200 □行相□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ □□□
201 同□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ □□□□□
202 □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ □□□□□
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□□□□□□□□□□□□□□□□□□□□□□□□ together beating and cursing, binding the left home people □□□ after sending the flesh eyes reversed sentient beings offering and sustaining □□□□□□□□□□□□□□□□□□□□□□□□□□□□□ □□ with monks, still saying the left-home people the rumour □□ holding the precepts □□□□□□□□□□□□□□□□□□□□□□□□ □□□□□□□□□□□□□□□□□ but such the Three Vehicles utensils the first significance monks collecting □□□□□□ precepts□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□covering and hiding □□□ precepts with □□□□□□□□□□□ □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ in □□□□□□□□□□□□□□□□□□ holding the precepts with one’s own evil three □□□□□□□□□□□□□□□□□□□□□□□□□□□□ □ after one first turn □□□□□□ within the Teachings also called dead body which is to be abandoned from □□□□□□□□□□□□ □□□□□□□□□ the World Honored One after my nirvā□a □□□ mind □ the Teachings monks the sage precepts not arousing themselves the evil all hundres of □□□□□□□□□□□□□□□□□□ □□□ own committed evil many times through of confession and repentation can be illiminated □□□ the various kinds of crimes as such further causeing my nine □□□□□□□□□□□□□□□□□□ □□□□ clutivating the merits and virtues to what can be reached, as expounded in the *Great Collective and Extensive Sūtra of Ten Wheels*.
□ further □ the *Great Parinirvā□a Sūtra* □□□□ thus □□□□□□ □□□□□□□□□ one □ wisdom eyes accomplishing bodhisattva punishing the sentient beings the depth, either beating or killing all obtain, either praising or slandering holding precepts or breaking precepts, or praising or slandering □□□□□□□□□□□□□□ Vehicle □□ or praising or slandering meritorious wisdom all obtain, as expounded in the scriptures □□□□ immortals and the king killing the Brahmans etc. all are conditioned □□□□□□□□ □□□□□□ deep, though not beating not killing those who keep the Eight Unclean Wealth committing a grave offense □□□□□ not make □ within the Three Vehicles serving the bodhisattvas □□□□ □□□□□□□□□ correspondingly similar.
2.4.10.9. Within the “Chapter on Moon Storehouse” of the *Great Collection Sūtra* also persons □□□□□□□□□ selecting the Teachings □□□□□□□□□□□□□□□□□□ is namely in the *Great Collective and Extensive Sūtra of Ten Wheels* judging all in-home and left-home □□□□□□□ persons such and with □□□□□□□□ □□□□□□□ in the *Great Collective and Extensive Sūtra of Ten Wheels* Buddha open to the king and chancellors and assistanting □□□□□ □□□□ Above are the human words and below are scriptural texts □□□□□□□□□□□□□□□□□

2.4.10.10. If they see those who have left their homes for my Teachings committing serious crimes, seriously killing living beings, seriously stealing, seriously lying, [committing] serious crimes and all other non good things. For all of such kinds [of crimes], according to the teachings they should be only discarded out of the land, out of towns and villages, not be allowed in the monastery, also further they may not do any undertakings with monks, things of profits and sustaining all should not be shared with them. [But] one should not whip [them], if one whips them it would be unreasonable. Also one should not orally condemn and curse them. All punishments should not be exerted to their bodies. If they break the Teachings on purpose and deserve the punishment, such persons fall down from the saving to the inferior genus, far from all the good ways of heavenly beings and human beings, must fall into the way of the Hell of Avīci, How much more it is to whip those who have left their homes and observe the precepts completely[30] □

2.4.11. clarifying the mundane persons who are fully endowed with ten kinds of evils □□□□□□. Why? Because for the sake of breaking the self-view, overweening pride, slandering the other people, slandering the dharma and the three wrong activities as well as the various kinds of evils. □□□□□ knowing breaking the precepts □□□□□□□□□□□□□□□□□ the Three Treasure fourthly not fearing and not eliminating other belief exerting punishing the way □□□□□□□□□□□ Sūtra Manjusri □□□□□□□□□ □□□□□□ two you superior comparing numerous returning mundane things fifthly from confession □□□□□□□□□□□□ Sutra Great □□ □□□□□□□□□□□□□□ just commenting on those five kinds of methods this scripture therefore knowing

2.4.12. Clarifying □□□□□□□□□□□themselves not □□□□ □□□□□□□□□□□□persons of this world commenting arousing □□□ □□□ evil because first clarifying □□□□□□□ □□□□□□□□□□□□□□□□□□□□□□□□□combining□□□□□□□□ Clarifying□ combining □ seek out of the Teachings persons□□□□□□□□□□□□□□□□□□□□□□□□□□□□ practice attributes □□□□□□□□□□□□□□□□□□□□ □□□□□□□□□□□□□□□□□□□□□□ same □□□□ □□□□□□□□□□□□□□□□□□□□

□□□

[1] In general the ten good actions are: 1. not killing; 2. not stealing; 3. not committing adultery; 4. not lying; 5. not speaking harshly; 6. not speaking divisively; 7. not speaking idly; 8. not being greedy 9. not being angry; 10. not having wrong views.On the contrary are the ten evil acts. But according to Xinxing's Manuscript (P.2283) he has his own definitaion for the ten evil activities: 1. 世间 those who are in the mundane world; 2. 肉眼 those who have flesh eyes; 3. 下行 those who have inferior practices; 4.下缘 those who have inferior conditions; 5. 在家 those who stay at home; 6. 后教 those who have the last teachings; 7. 恶行 those who have the evil practices; 8.恶时 those who are in the evil time; 9. 恶世界 those who are in the evil world; 10.恶众生 the evil sentient beings.

[2] The transcriber emended the originally carved "耶" to "邪".

[3] There is place for only one character for "明空有".

[4] The "Five Defilements" of the world: (1) the defilement of the trends of the present age; (2) the defilement of mistaken views; (3) the defilement of afflictions; (4) the defilement of being a sentient being; (5) the defilement of having a lifetime.

[5] According to the *Flower Garland Sutra* the ten aspects are 身身业、口口业、意意业、佛法僧戒, and the relating ten emptiness according to the manuscript from Dunhuang (P.2283) are correspondingly: 一身空、二身业空、三口空、四口业空、五意空、六意业空、七僧空、八法空、九佛空、十戒空.

[6] A mechanical restoration of the Chinese phonetic transliteration of the Sankskrit. This name is not found in any other sutra.

[7] The purified butter is regarded as the best of the milk products, and used in sutras as metaphor for nirvana or the true teachings.

[8] 2.2.5.1. and 2.2.5.2. are not identifiable.

[9] T16, no. 658, p235a.

[10] The fifth of the six perfections.

[11] The Ten Abidings among the fifty two stages of the bodhisattva as listed in the *Flower Garland Sutra*: 1. the abiding of awakening operation. 2. the abiding of nurturing. 3. the abiding of practice. 4. the abiding of producing virtues. 5. the abiding of replete with expedient means. 6. the abiding of correct mind. 7. the abiding of no-backsliding. 8. the abiding of the 'true child.' 9. the abiding of the dharma-prince. 10. the abiding of sprinkling water on the head.

[12] Āmala or tamarind (Tamarindus indica), is long-lived tropical evergreen tree with a spreading crown and feathery evergreen foliage and fragrant flowers yielding hard yellowish wood and long pods with edible chocolate-colored acidic pulp.

[13] See T16, no. 658, p235.

[14] T16, no. 658, p235.

[15] Curiously there is only place for one character for 2.4.2.1. and 2.4.2.2.

[16] There is place of four characters for the six characters "謗法邪三業等".

[17] 2.4.3.3. and 2.4.3.4. are not identifiable.

[18] The structure is unclear. Probably 2.4.4.6.6.

[19] Far away and quiet place, often it refers to monastry.

[20] solidary realizers

[21] Killing insects through oppressing oil from seeds. See T13, no. 411, p744.

[22] Unit of measure in ancient China, equals about 180 liters

[23] Those who are not willing to enter nirvana.

[24] Bad man. One of the ten disrupters.

[25] The name *Lüfengzi* 驢封子 is not found in any other sutras.

[26] See T13, no.410, p710a.

[27] In the *Great Nirvana Sutra* and *Lotus Sutra* there are parables of of Kālaka fruit and Tinduka fruit.

[28] 2.4.10.7. is not identifiable.

[29] From 2.4.10.7.1. to 2.4.10.7.5. compare 4.3.1.1.1. to 4.3.1.1.5. in the first text by Xinxing.

[30] T13, no. 397, p359.

0 《大集月藏分经》略抄出一卷 信行禅师撰

1 一者明供養三寶時節。 上人語下經文： 若復有諸衆生若現在世及未來世； 二

2 者明能自發心出家勤脩道者現得不捨諸佛乃至成佛。 上人語下經文： 於我法

3 中出家脩道三業相應； 三者明放人出家人現得不捨諸佛乃至成佛。 上人

4 語下經文： 若復放人出家脩道； 四者明守護供養聲聞弟子不斷現得不捨

5 諸佛乃至成佛。 上人語下經文： 若復有人能勤加護持養育供給我諸聲聞比丘

6 比丘尼優婆塞優婆夷令三寶種得不斷絕； 五者明脩六波羅蜜人現得不

7 捨諸佛乃至成佛。 上人語下經文： 若有能脩檀波羅蜜乃至般若波羅蜜； 六

8 者明造新塔新像及脩故塔故像人現得不捨諸佛乃至成佛。 上人語下經文： 若

The Abridged Excerpts from the "Chapter on Moon Storehouse" of the *Great Collection Sūtra*, One Scroll, Compiled by Meditation Master Xinxing

1. Clarifying the time and seaon to offer and sustain the Three Treasures. Above are the human words and below are scriptural texts: "If further any sentient beings in the present world and the future world"[1];

2. Clarifying those who themselves can arouse their minds to leave home and cultivate the Way diligently, in present shall not be abandoned by the Buddhas until they accomplish Buddhahood. Above are the human words and below are scriptural texts: "For my Teachings leave their home and practise the Way in accord with the three actions";

3. Clarifying those who allow other persons to leave their homes in present shall not be abandoned by the Buddhas until they accomplish Buddhahood. Above are the human words and below are scriptural texts: "If futher allowing other persons to leave their homes and practise the way";

4. Clarifying those who protect and defend, offer and sustain the voice-hearer disciples constantly in present shall not be abandoned by the Buddhas until they accomplish Buddhahood. Above are the human words and below are scriptural texts: "If furhter any person[2] can diligently defend and maintain, support and care, offer and supply my voice-hearer disciples *bhik□u, bhik□uni, upāsaka, upāsikā*[3], to cause the seeds of the Three Treasures not stopped and not extinguished";

5. Clarifying those who practise the Six Pāramitās in present shall not be abandoned by the Buddhas until they accomplish Buddhahood. Above are the human words and below are scriptural texts: "If any can practise [from] *dāna-pāramitā* even to *prajñā-pāramitā"*;

6. Clarifying those who build new pagodas, new Buddha statues as well as repair old pagodas and old Buddha statues in present shall not be abandoned by the Buddhas until they accomplish Buddhahood. Above are the human words and below are scriptural texts: "If any constructs and builds pagodas, temples and Buddha statues as well as repairs the old [ones]";

9 有營造塔廟形像及以脩故； 七者明供養四方僧造新寺及脩營故寺人現

10 得不捨諸佛乃至成佛。 上人語下經文： 種種捨施供養供給四方眾僧置立寺舍

11 及以修故； 八者明守護不聽他奪三寶財物人現得不捨諸佛乃至成佛。 上

12 人語下經文： 復於彼四方僧寺捨施種種衣服臥具器物所須及施田宅財寶

13 園林僮仆給使乃至畜生若復見他捨施諸物還追奪者以力遮護； 九者明

14 佈施聲聞衣服飲食臥具湯藥一切所須人現得不捨諸佛乃至成佛。 上人語下

15 經文： 若複施我聲聞弟子衣服飲食臥具湯藥一切所須； 十者明以自他力令

16 弟子脫苦惱現得不捨諸佛乃至成佛。 上人語下經文： 我之所有聲聞弟子或有

17 因緣遭遇苦惱若以自力若假他力方便令脫□□□□□□□□□□□□□

7. Clarifying those who offer and sustain the monks of the four directions, build new temples as well as repair and reconstruct the old temples in present shall not be abandoned by the Buddhas until they accomplish Buddhahood. Above are the human words and below are scriptural texts: “With various kinds of charities and donations offer and sustain, offer and supply the monks of the four directions, install and set up temples and monasteries as well as repair the old [ones]”;

8. Clarifying those who protect and defend, do not permit other persons snatching properties and belongings from the Three Treasures in present shall not be abandoned by the Buddhas until they accomplish Buddhahood. Above are the human words and below are scriptural texts: “Further in the monasteries and temples of the four directions bestow and donate various kinds of clothes, beddings, utensils and necessities as well as donate fields and houses, wealth and treasures, gardens and forests, servants and attendants, even to domestic animals. If further seeing other persons bestow and donate all those things but chase and snatch them back, cover and protect with power”;

9. Clarifying those who give alms to the voice-hearer disciples clothes, drinks and foods, beddings, hot water and medicines and all necessities, in present shall not be abandoned by the Buddhas until they accomplish Buddhahood. Above are the human words and below are scriptural texts: “If further donating my voice-hearer disciples clothes, drinks and foods, beddings, hot water and medicines and all necessities”;

10. Clarifying those who with the power of their own or others cause the disciples to get rid of sufferings and distress in present shall not be abandoned by the Buddhas until they accomplish Buddhahood. Above are the human words and below are scriptural texts: “All my voice-hearer disciples, if due to the causes and conditions they encounter the sufferings and distress, if any with own power or if by means of other’s power or expedients cause them to get rid of it”;

[11.] □□□□□□□□□□□ in present shall not be abandoned by the Buddhas until they accomplish Buddhahood. The scriptures Buddha[4] above ten kinds of persons etc. □□□□□□□□□□□□ □ Eon thousand Buddhas and even be able to enter the great city of fearless nirvā□a. Above are the

18 現得不捨諸佛及成佛。經文佛以上十種人等□□□□□□□□□□□□□

19 刼千佛乃至得入無畏涅槃大城。 上人語下經文： 我以如是诸众生等， 悉皆付嘱

20 十方現在一切諸佛，及付賢刼所有菩薩摩訶薩等，令其攝受生得相值。若彼賢

21 劫諸佛出世，是諸衆生于彼佛所作大施主，守护正法，持戒第一，得禅三昧，具足忍

22 力。如此贤劫最后如来出现于世，于是彼佛当授彼等阿耨多罗三藐三菩提记，

23 便得速满六波罗蜜，不久当为无上法王当入无畏涅般大城。□□□□□□□

24 □□□□□□□□□□□□□□□□□□□□□若有众生为我出家剃除

25 须发被服袈裟。设不持戒彼等悉已为涅槃印之所印也。□□□□□□□□□

26 □□□□□□□萨□物人滅□□□□□□□□□若複出家不持戒者，有以

27 非法而作惱亂，罵辱毀訾，以手刀杖打縛斫截，若奪衣缽及奪種種資生具者，是

28 人則坏三世诸佛真实报身，则挑一切人天眼目。□□□□□□□□□□□□

29 □□□□□□□□□□□□□□□□□□□□□□□□□□□□□

30 □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

31 □□□□□□□我等受寄护持养育世尊法眼，以诸方便令得炽然，护持三宝

human words and below are scriptural texts: “With all the sentient beings and so on as such, I will entrust them entirely to all the Buddhas in the present of the ten directions as well as to all the bodhisattvas mahasattvas and so on, to cause them salvated through the great compassion during their life time. If those Buddhas of the Good Eon come to the world, all those sentient beings will be the great donators in the places of the Buddhas, protect and defend the true Teachings, observe the precepts excellently, obtain the dhyāna samādhi, be full endowed with the power of endurance. In this way in the end of the Good Eon Tathāgata will appear in the world, and at that time that Buddha shall predict them the attainment of anuttarā-samyak-sa□bodhi. They shall quickly fulfill the Six Pāramitā, and soon be the Unsurpassed Dharma King, and be able to enter the great city of fearless nirvā□a”:

12. □□□□□□□□□□□□□□□□□□□□□□ If the sentient beings for me leave their homes, cut off their beard and hair, wear the ka□āya, provided they do not keep the precepts, they are completely impressed by the seal of nirvā□a. □□□□□□□□□□□□□□ □ bodhisattva □ things persons extinguished □□□□□□□□□ “If again to those who have left their homes but do not observe the precepts, any might make distress and disturbance by injustice, curse, insult, damage and slander them, with hand, knife or stick, beat, band, chop and cut them, or if snatch the clothes and alms bow and snatch various kinds of assets and equipments for living, that person spoils the true rewarded bodies of all Buddhas of three times, and provokes the eyes of all heavenly beings and human beings”[5];

13. □□□□□□□□□□□□□□□□□□□□□□□□□□□□ □□□□□□ □□□□□□□□□□□□□□□□□□□□□□□□ □□ □□□□□□□□□□□□□□□□□□□□□□□□□□□□ “We are entrusted to defend and maintain, support and care the dharma eyes of the World Honored One, by the expedient means cause them to be glorious, defend and maintain the Three Treasure long abiding and not extinguished, also can increase the three kinds of essence and energy to detach and obstruct the evils”[6];

14. Clarifying the various kinds persons who damage and spoil the Three Treasures learning cessation [and observation] the gains and losses the amount the terror and fear □□ vowing to offer and sustain, protect and defend the three kinds of *bhik□us* who observe, break or have no precepts. Above are the human words and below are scriptural texts:

32 久住，亦能增长三种精气遮障诸惡； 十四者明種種毀壞三寶人聞止損益多

33 少怖怕□□願供養守護持戒破戒無戒三種比丘。 上人語下經文： 既見此已所

34 有毀壞三寶者，皆無佛斎誠心懺悔護持三寶。於佛一切聲聞弟子，乃至若复不

35 持禁戒剃除鬚髮著袈裟片者，作師長想護持養育與諸所須令無乏少；

36 十五者明禪定比丘三寶人願遮護國王大臣等不令毀壞三寶。 上人語下經文：

37 若复有诸剎利國王，作諸非法惱亂世尊聲聞弟子，若以毀罵刀杖打斫，及奪衣

38 缽種種資具，若他給施作留難者，我等令彼自然卒起他方怨敵，及自國土亦

39 令兵起，病疫飢饉，非時風雨，鬪諍言訟，誹謗譏調。又令其王不久復當亡失己國。

40 如是若復諸婆羅門毗舍首陁男夫婦人童男童女，若餘天龍乃至迦吒富單那

41 等，於佛所有聲聞弟子作其惱亂。若奪精氣氣噓其身，乃至惡心以眼視之，我等

42 悉共令彼天龍乃至迦吒富單那等，所有諸根缺減醜漏不依處所； 十六者

43 明復有諸天等於三寶中作罪過者懺悔，願供養守護持戒破戒無戒三種比丘。

"After already seeing that, all those who damage and spoil the Three Treasures,[7] all have no Buddhist purified whole heartedness to repent and confess, defend and maintain the Three Treasures. To all the voice-hearer disciples of Buddha, even to those whomight further not observe the precepts but still cut off beard and hair and wear the sheet of ka□āya, you should regard them as master and senior, defend and maintain, support and care, supply them what they need and make them lack of nothing";

15. Clarifying the *bhik□us* of dhyāna concentration and persons of the Three Treasures vow to cover and protect the kings and chancellors from damaging and spoiling the Three Treasures. Above are the human words and below are scriptural texts: "If further any k□atriya kings, make all injustice to distress and disturb the voice-hearer disciples of the World Honored One, if they damage, curse, chop with knife and beat with stick, as well as snatch clothes and alms bows and various kinds of equipments for the living, or if other persons supply and donate, make difficulties by detaining, we cause them spontaneously suddenly having sworn enemies from other places, and in their own countries also cause to arise wars, illness, epidemic diseases, famine and starvation, unseasonable wind and rain，fighting and quarrel, argue and debate, slander and defame, satirize and provoke.
Also we will cause further the king soon to lose his country. In this manner if further the Brahmans, Vaiśya, Śūdra, men, women[8], boys and girls, if the other heavenly beings, dragons even to Katabhūtana[9] etc, if they distress and disturb all Buddha's voice-hearer disciples, if they snatch their essence and energy, and blow the body with air, and even with vicious mind watch them with eyes, we all together cause those heavenly beings, dragons even to Katabhūtana etc, all the roots incomplete and decreased, ugly and poor[10], not in accord with their places" [11];

16. Clarifying further the heavenly beings in the Three Treasures commit crimes but confess and repent, and vow to offer and sustain, protect and defend the three kinds of *bhik□us* who observe, break and have no precepts. Above are the human words and below are scriptural texts: "Then the heavenly beings and even to all Katabhūtana, human beings and non human beings etc with all the present assembly[12] in the place of Buddha [saying]: 'if our body, mouth and mind have committed crimes

44 上人語下經文： 尒時諸天乃至一切迦吒富單那人非人等所來大眾於世尊所，

45 若身口意所作罪過，及於法僧；若身口意所作罪過，乃至世尊一聲聞弟子所；若

46 身口意所作罪過，乃至若有爲佛剃髮著袈裟片作違反行非法器者；若身口意

47 所作罪過，是等諸罪悉於佛前誠心懺悔，脩戒威儀。願佛容恕受我等懺，當令我

48 得住戒威儀，又複我等從今已往，乃至剃髮著袈裟片作違反行者，及佛聲聞弟

49 子所，悉當發心作導師想，護持養育具足供給一切所須不令乏少； 十七者

50 明佛贊歎□□由懺悔發願守護三寶罪得除滅并□付囑三寶人真□义□。

51 上人語下經文： 佛言：善哉善哉。諸妙丈夫成就忍辱，乃至汝等於我佛所。若身口意

52 所作罪過，若於法僧所作罪過，乃至於我一聲聞弟子；若身口意所作罪過，乃至爲

53 我剃除鬚髮著袈裟片者；若身口意所作罪過，各自深观如是罪業，誠心懺悔，皆

and offences to the Teachings and monks, if our body, mouth and mind have committed crimes and offences even to one place of voice-hearer disciple of the World Honored One; if our body, mouth and mind have committed crimes and offences even to those who might for Buddha cut off his hair and wear the sheet of ka□āya, who made failing deeds and were non suitable Buddhists; if our body, mouth and mind have committed crimes and offences, all those crimes are entirely in front of Buddha wholeheartedly repented and confessed to cultivate the deportment of precepts. We implore that Buddha tolerate and forgive and accept our repentance, and make us abiding the deportment of precepts, further we from now on, even to those how cut their hair and wear the sheet of ka□āya who made failing deeds, and to the place of Buddha's voice-hearer disciples, completely should arouse our mind to regard them as the master, defend and maintain, support and care, fully offer and supply them all what they need and make them lack of nothing'" [13];

17. Clarifying Buddha praising □□ out of repenting and confessing arousing the vow to protect and defend the Three Treasures, the crimes will be removed and decreased and □ entrust the persons of the Three Treasures true □ significance □. "Above are the human words and below are scriptural texts: Buddha said: 'Excellence, Excellence. All wonderful men accomplish the patience and forbearance, and even you in the place of my Buddha, if your body, mouth and mind have committed crimes and offences, if you have committed crimes and offences to the Teachings and the monks, and even to one of my voice-hearer disciples, if your body, mouth and mind have committed crimes and offences, and even to those who for me cut their beard and hair and wear sheets of ka□āya, if your body, mouth and mind have committed crimes and offences, you respectly deeply contemplate such actions of crimes and wholeheartedly repent and confess, [the crimes] will be completely removed and erased, and will be not evilly rewarded. Therefore you should all protect and defend, supply and care my Teachings, and even to those who for me leave their homes, cut their hair, do not observe the commandments and precepts, [but] wear the sheets of ka□āya, you should all protect and defend, supply and care. If you can protect and defend, supply and care, it is greatly appraisable'"[14];

18. Clarifying □□□□□□□□□ such offer and sustain, protect and defend the Teachings of the Three Treasures, should first offer and sustain,

54 得除滅不受惡報。如是汝等皆當護持養育我法，乃至爲我出家剃發不持禁戒

55 著袈裟片者，汝等皆應護持養育，若能護持養育此者深可讚歎；　十八者明

56 □□□□□□□□□此供養守護三寶法，先須供養守護破戒無戒兩種比丘，然

57 □□□□□□□□□□。 上人語下經文： 若我所有聲聞弟子持戒具足，多聞智慧，

58 解脫知見，悉具足者，汝等皆應護持養育。彼等自以過去善根福德因緣善得供

59 養。若有衆生於未來世無智慧福德， 為我剃髮著袈裟片，不受禁戒或受毀犯，於

60 諸善法不得相應，若複護持養育此者得無邊福；　十九者明佛付囑諸天等

61 □□□□□□□□□□應供養守護亦由□□□供養。我與彼等作善導師憐

62 憫利益。何以故？當來之世有惡眾生，於三寶中少作善業。若行佈施若複持戒脩

63 諸禪定，以其如是少許善根作諸國王，愚癡無智無羞慚愧憍慢熾盛，無有慈愍

64 不觀後世可怖畏事，彼等惱亂我諸所有聲聞弟子，打縛罵辱，或復駈使令其供

65 給，奪其飲食衣缽湯藥所須之物寺舍園田，系閉牢獄擯徙謫罰，乃至剃髮著袈

protect and defend the two kinds of *bhik□us* who break and have no precepts, and then □□□□□□□□□□. Above are the human words and below are scriptural texts: “If all my voice-hearer disciples observe the precepts fully, learn widely and are of wisdom, and their knowledge and vision of liberation are all fully completed, you should all defend and maintain, sustain and care. By their good roots, meritorious virtues, causes and conditions of their past lives, they obtain well the offering and sustaining. If any sentient beings in the future world have no wisdom and meritorious virtues[15], [but if they] for me cut the hair, wear the sheets of ka□āya, [though they] do not accept the precepts and commandments or accept but damage and break [the precepts], which are not in accord with all the good Teachingss, if one would protect and defend, supply and care those persons, one would obtain limitless merits” [16];

19. Clarifying Buddha entrusted all heavenly beings etc. □□□□□□ □□□□ should offer and sustain, protect and defend also from □□□ offer and sustain. “I and they would be the good masters and feel compassionate and bring benefit for them. Why? In the coming world there are evil sentient beings, who make littel good things to the Three Treasures, and possibly they might practise charity and give donations, or possibly further observe precepts and cultivate the dhyāna concentrations, with those little good roots they become the kings, who are stupid and foolish, have no wisdom, no shame or repentance, but flamingly conceit and arrogance, have no mercy and kindness, and they do not contemplate the frightening and horrible things in the worlds after them. They distress and disturb all my voice-hearer disciples, beat and band, curse and insult, or further force them to supply tribute, snatch their drinks and foods, clothes and bows, hot water and medicine, the necessities, temples and monasteries, gardens and fields, they fasten, close, imprison, expel, drive out, reproach and punish [the disciples], and even do the same things to those who cut their hair and wear the sheets of ka□āya. As to the crowd of ministers and the judges, they are foolish and stupid, have no wisdom, away from all the [Buddhist] scriptures and treatises, have no mercy and sympathy, do not contemplate the frightening and horrible things in the world after them. They distress and disturb all my voice-hearer disciples, and even imprison, expel and punish them, and even do the same thing to those who cut their beard and hair and wear the sheets of ka□āya for me. Today I entrust all those

66 裟片者亦複如是，及以群臣諸斷事者，癡愚無智離諸經論，無有慈悯 不觀後世

67 可怖畏事。彼等惱亂我諸聲聞，乃至系獄擯徙謫罰，乃至為我剃除鬚髮著袈裟

68 片者亦複如是。我今以此諸出家者悉付於汝，勿令彼等飢渴孤獨致於命終；

69 廿者明□□□□□□□□□□□惱亂破戒無戒兩種比丘□□多少。 上人

70 語下經文： 爾時上座阿若憍陳如從座起，作如是言：大德婆伽婆，彼等刹利若

71 婆羅門毗舍首陀，如是等人惱亂聲聞弟子得幾許罪，且置持戒，若复為佛

72 剃除鬚髮著袈裟片，不受禁戒受而毀犯，惱亂此者得幾許罪？佛言：止止，憍陳如，

73 莫問此事□□□□□□□□□；廿一者明佛答惱亂罵辱打縛僧尼人得罪

74 幾許。 上人語下經文： 佛言大梵我今為汝且略說之。若有人於萬億佛所出其身

75 血，於意雲何，是人得罪寧爲多不？大梵王言：若人但出一佛身血得無間罪，尚多

76 無量不可算數，墮於阿鼻大地獄中。何況具出萬億諸佛身血者也，終無有能廣

home-lefter entirely to you, please do not leave them hungry, thirsty, lonely and isolated and even to die” [17];

[20. Clarifying] □□□□□□□□□□□ distress and disturb the two kinds of *bhik□us* who break and have no precepts□□ the amount. Above are the human words and below are scriptural texts: “And then the senior-seated one Ājñāta-kau□□inya, arose from his seat and said the followings words: ‘Great Virtue Bhagavat, all they k□atriya as well as Brahmans, vaiśya, śūdra, such persons distress and disturb the voice-hearer disciples, how much crimes do they get? Except for those who observe the precepts, if futher to those who cut off their beard and hair and wear the sheets of ka□āya for Buddha, do not accept the precepts and commandments, or accepted but damage and break them, how much crimes do they get if they distress and disturb those persons?’ Buddha said: ‘Stop! Stop! Kau□□inya, do not ask about this thing □□□□□□□□□’” [18];

21. Clarifying Buddha answering about how much crimes one get for distress and disturb, curse and insult, beat and bind the monks and nuns. Above are the human words and below are scriptural texts: “Buddha said: ‘Great Brahman, Today I briefly expound it to you. If one in the place of trillion Buddhas makes their bodies bleeding, what do you think, the crimes that one will get are much or not?’ The King of the Brahma Heaven said: ‘If one makes just one Buddha’s body bleeding, one will immediate crimes, which are too much to numerate, and [the one] will fall into the great Avīci Hell, how much more it is to make entirely trillion Buddhas’ body bleeding? For that no one could extensively say the crimes of the actions and the results and rewards of that person, except Tathāgata.’ Buddha said: ‘Great Brahman, if one distress and disturb, curse and insult, beat and bind those who cut their hair and wear the sheets of ka□āya, [even though they] do not accept precepts and commandments or accept them but break them, one get more crimes than that’”;

22. Clarifying distressing and disturbing, cursing and insulting, beating and binding the monks and nuns getting crimes broad and much □□□□□□□□□□□□□ Above are the human words and below are scriptural texts: “Why? Those who leave their homes, cut their hair and wear sheets of ka□āya for me, [though keep] away and do not accept the

77 說彼人罪業果報，唯除如來。佛言：大梵，若有惱亂罵辱打縛為我剃髮著袈裟片

78 不受禁戒受而犯者，得罪多彼；　廿二者明惱亂罵辱打縛僧尼人得罪廣多

79 □□□□□□□□□□□□□。 上人語下經文： 何以故？如是為我出家剃髮著

80 袈裟片離不受戒或受毀犯，是人猶能爲諸天人示涅槃道，二由減破戒無戒兩

81 種比丘□□□□□□□□□□□，是人便已於三寶中心得敬信，勝於一切九

82 十五道，其人必速能入涅槃，勝於一切在家俗人，唯除在家得忍辱者，是故天人

83 應當供養。何況具能受持禁戒三業相應；　廿三者明佛教國王等治罪破戒

84 □□□□□□□□□□□□□□□□□中留遣國王大臣留□出家人治罰

85 □□□□□□□□□□□□□□□□□其有一切剎利國王及以群臣諸斷

86 事者，如其見有於我法中而出家者，作大罪業、大煞生、大偷盜、大妄語、大非梵行

87 及餘不善，如是等類但當如法擯出國土、城邑、村落，不聽在寺。亦複不得同僧事

88 業，利養之物悉不共同。不得鞭打，若鞭打者理所不應。又亦不應口業罵辱，一切

89 不應加其身罪，若故違法而謫罰者，是人於解脫退落受於下類，遠離一切人

precepts or accept but damage and break them, those persons can still show the Way of Nirvā□a to all the heavenly beings and human beings. Second from reducing the two kinds of *bhik□us* who break and have no precepts[19] □□□□□□□□□□□, Such persons have already obtained heartedly the reverence and trust in the Three Treasures, better than all other Ninty-five Ways, the persons must be able to enter nirvā□a quickly, better than all the laymen at home, only except those who obtain the patience and forbearance at home, therefore the heavenly beings and human beings should offer and sustain them. How much more it is to those who can fully accept and observe the precepts and commandments in accord with the Three Actions";

23. Clarifying Buddha instructing kings and so on punishing breaking the precepts □□□□□□□□□□□□□□□□□□ inside staying dispatching kings chancellors staying □ the home-left persons penalty □□□□□□□□□□□□□□□□□□ "There are all k□atriya kings and their all ministers and judges, if they see those who have left their homes for my Teachings committing serious crimes, seriously killing living beings, seriously stealing, seriously lying, doing serious unclean deeds and all other non good things. For all of such kinds [of crimes], according to the Teachings they should be only discarded out of the land, towns and villages, not be allowed in the monastery, also further they may not do any undertakings with monks, things of profits and sustaining all should not be shared with them. [But] one should not whip [them], if one whips them it would be unreasonable. Further also one should not orally condemn and curse them. All punishments should not be exerted to their bodies. If they break the Teachings on purpose and deserve the punishment, such persons[20] fall down from the saving and to the inferior genus, far from all the good paths of heavenly beings and human beings, must fall into the way of the Hell of Avīci, How much more it is to whip those who have left their homes and hold completely the precepts" [21][22];

24. Clarifying □□□□□□□□□□□□□□□□□□ accomplishing, breaking and having no precepts the three kinds of *bhik□us*. Above are the human words and below are scriptural texts: "Then there are all kinds of heavenly beings and all kinds of dragons, and even all Katabhūdana and the present assembly, who obtain the superior belief, respect and reverence and the mind of cherishing. Further they said the following words: 'We all from now on, protect and maintain, supply and care the

90 天善道，必定歸趣阿鼻地獄，何況鞭打爲佛出家具持戒者； 廿四者明□□

91 □□□□□□□□□□□□□□□成破無戒三種比丘。 上人語下經文： 爾

92 時複有一切諸天一切諸龍，乃至一切迦吒富單那諸來大眾，於三寶中得增上信

93 尊重敬仰及希有心，複作是言：我等一切從今已往，護持養育世尊正法，及與比

94 丘比丘尼，優婆塞優婆夷，乃至毀犯佛禁戒者，我等亦當攝受護持，乃至為佛剃

95 除鬚髮著袈裟片不受禁戒無所積聚，我亦於彼作導師想，護持養育供給所須，

96 皆令具足； 廿五者明□□□諸餘聖眾願遮護國王大臣等不令鞭打出

97 家比丘。 上人语下经文： 若諸國王见有如是爲佛出家受持禁戒，乃至為佛剃除鬚

98 髮著袈裟片不受禁戒受而毀犯無所積聚，如其事緣治其身罪鞭打之者，我等

99 不復護持養育如是國王。舍離彼國，以舍離故令其國土而有種種诌詐鬥诤疫

100 病饑饉刀兵俱起，非時風雨亢旱毒熱傷害苗稼。又若我等舍離彼國，當勤方便

101 令其國土所有世尊聲聞弟子悉向他國，使其国土空无福田。若有世尊聲聞弟

102 子，乃至但著袈裟片者，若有宰官鞭打彼等，其刹利王不遮護者，我等亦當出其

correct Teachings of the World Honored One, and the *bhik□u, bhik□uni, upāsaka, upāsikā*, and even those who damage and break Buddha's precepts and commandments, we should also collect and accept them, protect and maintain them, and even to those who cut their beard and hair, wear sheets of ka□āya for Buddha, but do not accept the precepts and commandments, and have no accumulation [of merits], we should also regard them as the masters, protect and maintain, supply and care, offer them fully what they need'".

[25. Clarifying] □□□ the other sages will cover and protect the kings and chancellors etc. from whipping and beating the home-left *bhik□us*. Above are the human words and below are scriptural texts:
"If the kings see those who leave their homes and accept and observe the precepts and commandments for Buddha, and even those who cut beard and hair, wear sheets of ka□āya for Buddha, but do not accept the precepts and commandments, or accept but damage and break them, and have no accumulation [of merits], because of that thing they punish their bodies and whip them, we will no langer protect and maintain, supply and care such kings. We abandon and leave that country, and beause of our abandoning and leaving the country causing various misfortunes to happen together in the country, like cheating, disputing, famine and war, unseasonable wind and rain, heavy drought, malicious heat, hurting and killing the seedling and plants, further if we abandon and leave the land, we should diligently be expedient means cause all the voice-hearer disciples of the World Honored One completely leave for other lands, to make the land empty without the field of merits. If the voice-hearer disciples of the World Honored One, and even those who wear the sheets of ka□āya, if governor would whip and beat them, and their k□atriya king do not cover and protect, we should also exit leave the land" [23];

26. Clarifying □□□□□□□□□□□□□□□□□□□□□□□□□□ □□□□□□□□□□ "Then the World Honored One told the Moon Store Bodhisattva Mahasattva saying, You should understand and know the clean and pure land. If I abide in the world, all voice-hearers have complete precepts, complete abadon [of secular life], complete learning, complete determination, complete wisdom, complete salvation, complete knowing and understanding of salvation. My correct Teachings is glorious in the world, and even to all the heavenly beings and human beings also is also shown and manifested the equal correct Teachings. Within the five

103 國土； 廿六者明□□□□□□□□□□□□□□□□□□□□□□□□□

104 □□□□□□□□□□爾時世尊告月藏菩薩摩訶薩言：了知清淨土。若我住

105 世諸聲聞衆，戒具足，舍具足，聞具足，定具足，慧具足，解脫具足，解脫知見具足。我之

106 正法熾然在世，乃至一切諸天人等，亦顯現平等正法。於我滅後五百年中，諸比丘

107 等猶於我法解脫堅固，後五百年我之正法禪定三昧得住堅固，後五百年讀誦

108 多聞得住堅固，後五百年於我法中多造塔寺得住堅固，後五百年於我法中鬥

109 諍言訟白法隱沒損減堅固； 廿七者□□□滅度二千年已後供養破戒無戒

110 兩種比丘□□□□□□□□□□□□□了知清淨土。從是已後於我法中，雖

111 復剃除鬚髮身著袈裟，毀破禁戒行不如法，假名比丘。如是破戒比丘名字，若有

112 檀越施捨供養護持養育，我說是人猶得無量阿僧祇大福德聚，何以故？猶能饒

113 益多衆生故，何況我今現在於世； 廿八者喻說就時明佛法邪正多少淺深

114 義。 上人語下經文： 譬如真金為無價寶，若無真金銀為無價寶， 若無銀者鍮石為

hundred years after my nirvā□a the *bhik□us* still have solid salvation in my Teachings, within the next five hundred years in my correct Teachings and dhyāna concentrations samādhi abide in solid [basis], within the next five hundred years reading and reciting and more learning abide in solid [basis], within the next five hundred years in my Teachings building many pagodas and temples abide in solid [basis], within the next five hundred years in my Teachings quarrel and disputation[24], the clean Teachings is concealed and the solid [basis] is decreased and damaged” [25];

27. □□□ nirvā□a two thousand years later offering and sustaining the two kinds of *bhik□us* who break, have no precepts □□□□□ □□□□□□□□ “understanding and knowing the clean and pure land. From now on[26] in my Teachings, though they further cut their beard and hair, wear the ka□āya, but they damage and break the precepts and commandments and do not behave according to the Teachings, with the false name of *bhik□u*. Such name of breaking precepts *bhik□us*, if one donator would bestow and donate, offer and sustain, protect and maintain, supply and care, I say that that person will still obtain the infinite asa□khyeya great assemblance of meritorious virtue. Why? They can still be richly beneficial to many sentient beings, How much more it is I now live in the world”;

28. Expounding with parables as to the time clarifying the significance of the amount and depth of the false and correct Teachings. Above are the human words and below are scriptural texts: “For instance, the genuine gold is the invaluable treasure, if there is no genuine gold, silver is the invaluable treasure[27]; if there is no silver, brass stone is[28] the invaluable treasure; if there is no brass stone, the forged treasure is[29] the invaluable; if there is no forged treasure, red copper[30], white iron[31], lead and tin are the invaluable. In a similar way in all worlds the treasure of Buddha is the most unsurpassable. If there is no treasure of Buddha those solidary realizers are the most unsurpassable; if there are no solidary realizers and the arhats are the most unsurpassable; if there are no arhats the other sages are the most unsurpassable; if there are no sages the worldlings[32] who have obtained the concentration are the most unsurpassable; if there are no persons obtaining the concentration, those who have pure and clean[33] precepts[34] are the most unsurpassable; if there are no persons have pure precepts, those[35] who have dirty precepts

115 無價，若無鍮石偽寶為無價，若無偽寶赤白銅鎦白鑛鉛錫為無價寶。如是一切

116 諸世界中佛寶爲無上，若無佛寶緣覺為無，若無緣覺羅漢為無上，若無羅漢

117 諸餘聖眾以為無上，若無聖者得定凡夫為無上，若無得定清淨戒者為無上，若無

118 淨戒汙戒以為無上，若無汙戒剃頭著袈裟名為比丘為無上寶。比餘九十五種異

119 道最尊第一，應受世供以為福田。何以故？能示眾生可怖畏故；　廿九者明佛

120 □□□供養無戒比丘《涅槃經》□□。 上人語下經文： 若有護持養育安置是人

121 不久得住忍地。 以上大集經第 卷 上人自說 己下是 第 卷 說；　卅者明

122 □□□此一切國王並及正法付囑諸天阿脩羅等種種異生眾，令其守護

123 □□□明佛□應或五百年後或一千年後或一千五百年後或二千年後

124 □□□□□□大菩薩有緣□盡諸佛大菩薩不能守護住持，如下偈中說彌

125 □□□□乘不能守護三寶，或唯有與三界惡眾生有緣三寶在，所以唯有惡

are the most unsurpassable; if there are no persons who have dirty precepts, those who cut their hair and wear ka□āya and are called as *bhik□u* are[36] the most unsurpassable treasure, who are compared with the other ninty-five heretics are the most honorable, should be offered by the world as[37] the fields of merits. Why? Because they can should the sentient beings the terrible and horrible";

29. Clarifying Buddha □□□ offering and sustaining the *bhik□us* of no precepts the *Nirvā□a Sūtra* □□ Above are the human words and below are scriptural texts: "If one protect and maintain, supply and care, help those persons settle down, one will soon abide the stage of patience [of the non-production of dharmas]. Above are from the scroll no. of the *Great Collection Sūtra*[38], Above are human own speech following are the expounding from the scroll no. ";

30. Clarifying □□□ those all kings as well as the correct Teachings entrusting all heavenly beings, Asuras and various kinds of different beings and so on, making them protect and defend □□□ clarifying Buddha □should either after five hundred years or after one thousand years or after one thousand and five hundred years or after two thousand years □□□□□□ great bodhisattvas have conditions □ completely all Buddhas and great bodhisattvas can not protect and defend and preserve and maintain [the Teachingss], as expounded in the following verse that Maitreya □□□□ Vehicle can not protect and defend the Three Treasure, or only those Three Treasures which have conditions with the evil sentient beings of the three realms remain,, therefore only the evil □□□□ from now on can not protect and defend, maintain and preserve returning this Teachings the land and the Teachings all completely entrust the heavenly beings and so on and various kinds of different □□□□□□□ "Then the World Honored One smiled merrily and pleased, from his forehead various kinds of light were released, shining all the directions. Then in the four worlds under the sky, appeared infinite hundred thousand Buddhas everywhere, [39] and also the same amount of pagodas and temples, which were the same kind of amount as the Buddhas. [40] In such places all my voice-hearers of the present and the future were in accord with the three actions, as well as in accord with the three kinds of bodhi. Those who were on the stage of learning and those who have finished their learning observed the precepts fully and completely, and they have learned much and done the good deeds, saving the sentient

126 □□□□從此不能守護住持歸此法國土及佛法皆悉付囑諸天等種種異

127 □□□□□□□爾時世尊熙怡微笑，從其面門放種種光照曜諸方。即時於

128 此四天下中，而有無量百千諸佛處處而現。還有如是等數塔寺，多少與佛一種。

129 於彼彼處，我諸聲聞現在未來三業相應，及與三種菩提相應。有學無學具足持

130 戒多聞善行，度諸衆生於三有海，及諸施主為我聲聞而造塔寺，亦復供給一切

131 所須及彼眷屬。付囑汝等，勿令惡王非法惱亂，又復勿令他方怨敵盜賊水火人

132 非人等之所恐怖，亦勿令彼飢渴乏少，以乏少故於三善業不得相應，退捨禁戒

133 善朋減損。爾時復有諸梵天王諸釋天王諸龍王諸夜叉王諸阿脩羅王諸鳩

134 槃荼王，皆與眷屬合掌向佛而作是言：大德婆伽婆，已有一切如來塔寺及阿蘭

135 若處，現在世尊聲聞弟子所有住處，及未來世，剎利婆羅門毗舍首陁，若在家人

136 若出家人，爲於世尊聲聞弟子造塔寺處，隨有世尊聲聞弟子三業相應，及與三

137 種菩提相應，有學無學住於持戒多聞善行，我等悉共守護於彼，令離一切諸難

beings from the see of the three kinds of existence, and all donator for my voice-hearers built the pagodas and temples, also further supply all what they needed as well as to their followers. Buddha requested you, that you should not permit the evil kings against the Teachings distressing and disturbing [them], and further you should not permit the resenting[41] enemies, robber and thieves, water and fire, human beings and non human beings etc. from other places terrifying and frightening them, also should not make them hungry and thirsty and short and lack of necessities, beause of short and lack of necessities they were not in accord with the three good actions, [thus] receded and abandoned the precepts and commandments, and the good friends reduced and damaged. Then there were further the Brahman Heaven Kings, the Śakra Devānām-indra Kings, the Dragon Kings, Yak□a Kings, Asura Kings, Kumbhā□□a Kings, all together with their followers folding their hands to Buddha and said the following words: ‘Great Virtue Bhagavat, for all the existing Tathāgata’s pagodas and temples and the places of ara□ya, all the present abiding places of the voice-hearer disciples of the World Honored One, and in the future world, if k□atriya, Brahmans, vaiśya and śūdra, the staying home persons or the left-home persons, build the places of pagodas and temples for the voice-hearer disciples of the World Honored One, any who are in accord with the three actions of the voice-hearer disciples of the World Honored One, as well as in accord with the three kinds of bodhi, those who are on the stage of learning and those who have finished their learning observing the precepts fully and completely, learning much and doing the good deeds, we all together protect and defend them, keep them away from all difficulties, fear and terror[42]. All places of pagodas and temples built for the voice-hearer disciples of the World Honored One and the places of ara□ya, if one would supply and donate drinks and foods, clothes, beddings, hot water and medicine and all what are needed, such donators we should also protect and maintain, supply and care. If further the voice-hearer disciples of the World Honored One, are shorten of the necessities in the day and night, poor and deficient of all means, we will be the great donator for them, grant them donation, protect and maintain, supply and care, keep them away from the terror and frightenings.’ Then Buddha praised: ‘Excellent, Excellent, all sage leaders, you all should be in this way in the four worlds under the sky. Now you[43] accept my treaching and instruction, and should practice as said, and I entrust you and your followers to the Maitreya’” [44];

138 畏怖。諸有世尊聲聞弟子所立塔寺及阿蘭若處，如有給施飲食衣服臥具湯藥

139 一切所須，如是施主我等亦當護持養育。若復世尊聲聞弟子乏少晝夜所須眾

140 具貧苦之者，我為彼等作大施主受其寄付護持養育除諸怖畏。佛時讚言：善哉

141 善哉。諸賢首汝等一切於四天下應當如是。如今等受我教敕如說脩行，我以汝

142 等及諸眷屬付囑彌勒； 卅一者明偈誦重誦。 上人語下經文： 爾時佛申金色

143 右臂而說偈言： 汝等共諦聽 一切有為法 無常火所燒 無有少常者 譬如諸戲

144 人 作於種種戲 如是等眾生 皆為煩惱轉 猶如幻芭蕉 亦如水中月 三界有為法

145 一切皆如是 諸法我自覺 道成如先佛 我今大眾會 天人作證明 正法付天神 護

146 持眾苦盡 成於三界尊 能令法熾盛 顯現八正路 邪意惡覺滅 沙門剎利王 激動

31. Clarifying the reiterating verse. Above are the human words and below are scriptural texts: “Then Buddha extended his golden right arm and said the verse:

You altogether attentively listen:
All the conditioned Teachingss,
Are burned by the fire of impermanence,
And they are none of a little permanence,
As comparable with the theatrical shows,
By which just various kinds of shows are made,
The sentient beings like those,
Are all turned by the afflications,
Just like the illusionary banana plants,
Also like the moon in water.
The conditioned Teachingss in the three realms,
All of them are in the same manner
All the Teachings I have myself realized,
And accomplished the way like the former Buddhas.
I am now together with the assembly.
The heavenly and human beings will testify,
[That I] entrust the true Teachings to the heavenly gods,
Protect and maintain all the suffering exhaustively,
And become the Honored One in the three realms,
Can make the Teachings glorious and flourishing,
Illustrate and show the Eight Right Ways,
Reduce the evil thoughts and the bad awareness,
Śrama□a and k□atriya king.
Became irrated and angry with each other[45].
From now on I would soon,
Enter the nirvā□a without remainder.
My voice-hearers with great wisdom,
Also follow me into nirvā□a,
The Buddha lands of the other directions,
All the bodhisattvas,
Who have the great spiritual powers,
Also return to the other places.
The kings with meritorious virtues,
And the chancellors and seniors will die out.
After the limit of one full hundred years,

147 相瞋惱 我今當不久 涅槃滅無餘 大智諸聲聞 亦隨我涅槃 餘方諸佛國 一切諸

148 菩薩 具大神通者 復還向他方 福德諸國王 大臣長者滅 限滿百年後 佛法漸隱

149 沒 薄福眾生等 於我法出家 不樂於三乘 亦不畏後世 活命故出家 多詐無羞恥

150 貪求諸名利 處處諂嫉妬 遠離於禪誦 複於諸善法 晝則樂言訟 夜則多睡眠 樂讀

151 外雜典 捨離佛所說 復與女人通 嚴飾身衣服 為求名利故 但營世俗業 常為他

152 作使 通致諸信命 往返俗人家 販賣以自活 樂作諸田業 又復喜鬪諍 見諸善比

The Teachings will be gradually concealed and submerge.
The sentient being with poor merit,
Leave their homes for my Teachings,
Having no pleasure from the three Vehicles,
Also having no fear for the later world.
For the sake of living they leave home.
They are dishonest and have no sense of shame,
Greedy for the fame and wealth;
Everywhere they flatter or envy,
Far from meditation and recitation,
Also from all good Teachingss;
Daily they enjoy orally disputing,
In the night they sleep much;
[They] enjoy reading the heretic miscellaneous books,
Abandon and detach from what Buddha has expounded;
Further they have relation with women,
Decorate and adorn their bodies with clothes;
For the sake of fame and wealth,
They practice the secular profession;
Often [they] work as a courier for the others,
Connect and send the letters and commands,
Go back and forth between the houses of the laymen;
By trading and selling [they] make themselves a living,
Enjoy managing the farms and professions.
Further they are fond of fighting and quarrelling,
They see the good *bhik□us*,
Who purely practice and widely learn.
They become jealous and further look and curse angrily,
And do not tolerate them sitting or sleeping.
But say rough and crude words,
Slander, damage and blame them.
By the side of the laymen,
They praise the non good actions;
Say that those *bhik□us* are dishonest,
They are thieves and the worst.
If one offers and sustains them,
One will get his evil name well known.
From them one finds no merits,
And also do not trust what they say.

153 丘 梵行多聞者 嫉妬復瞋罵 不容彼坐臥 而作麁穢語 誹謗及毀呰 於諸俗人邊

154 稱揚不善業 言此詐比丘 是賊最惡人 若有供養者 多得惡名聞 於彼不獲福 亦

155 莫信彼說 諸寺惡比丘 盜說梵行者 種種不善事 是以剎利瞋 彼諸惡比丘 雜以

156 外文頌 稱讚彼剎利 能令剎利喜 毘舍婆羅門 利喜亦如是 以是得供養 持戒被

157 欺陵 剎利婆羅門 嫌恨持戒者 嫌恨持戒故 致使諸天瞋 棄捨彼國土 剎利輔相

158 臣 向於寶國土 在彼而安住 輕賤持戒故 菩薩亦捨離 諸天捨離後 其國大可畏

159 惡龍惡夜叉 羅剎鳩槃荼 入國奪精氣 及食其肉血 惡王婆羅門 毘舍首陀等 共

All those evil *bhik□us* from the temples,
Cheatingly denounce those pure practitioners,
With various kinds of non good deeds,
Therefore k□atriya become angry.
Those evil *bhik□us*,
With the mixed heretic texts eulogize,
Praise and laud that k□atriya.
They can make the k□atriya happy,
To Vaiśya and Brahmans,
Favorable and happy in the same manner too.
By means of that they obtain the offering and sustaining,
Those who observe the precepts are bullied and humiliated,
K□atriya and Brahman,
Dislike and hate those who observe the precepts,
Because [they] dislike and hate [those who] observe the precepts,
That causes the angry of the heavenly beings.
They abandon and leave that land,
K□atriya and the chancellors and ministers,
For the land of treasure,
Where they safely live.
Because [they] contempt and belittle [those who] observe the precepts,
Bodhisattvas have also abandoned and left [the land].
After that the heavenly gods have abandoned and left,
The land becomes tremedously horrible,
The evil dragons and the evil Yak□as,
Rak□as and Kumbhā□□a,
Break into the land to snatch the essence and spirits,
And eat their flesh and blood,
The evil king and the Brahmans,
Vaiśya and śūdra and others,
Together protect the land, city and town,
As well as the villages.
In palaces, houses, gardens and forest,
Everywhere in those places are fulfilled with evil ghosts
They constantly snatch their essence and spirits,
Stir up and annoy the k□atriyas,
Brahmans, vaiśya and śūdra.
Men and women are all angry,
And further their mind become evil.

160 護國城邑 及以諸村落 宮舍國園林 惡鬼遍充滿 常奪彼精氣 觸惱諸剎利 婆羅

161 毘舍陀 男女等皆瞋 復令心變惡 互共相鬪諍 彼等鬪諍故 布薩行檀絕 其國水

162 枯涸 非時風雨起 飢饉復短 乏少資生具 果苗不成熟 地味眾生味 法味及精氣

163 一切皆損減 興動諸兵仗 互共相劫奪 如是慳貪國 惡比丘往返 復以佛僧物 飲

164 食諸果藥 持用與俗人 因此得供養 奴婢及田宅 與彼令攝受 不善比丘等 以之

165 為尊長 少智詐多聞 不喜禪戒者 禪戒者去後 為財共鬪諍 剎利聞生瞋 打害惡

They struggle and quarrel with each other.
Because they struggle and quarrel,
Charity and donation are exhausted.
Water in the land is dried up,
The non-seasoned wind and rain arise,
Famine and starvation is further short[46],
Necessities for living are in shortage and lack,
Fruits and seedlings do not grow mature,
The flavor of the earth and the flavor of the sentient beings,
The flavor of the dharma and essence and energy,
All are entirely reduced and decreased.
Agitated and activated are the wars and struggles,
Together and with each other they rob and snatch.
In such stingy and greedy land,
There is an evil bhik□u going forth and back.
Further he uses the belongings of Buddha and monks,
Drinks and foods and the fruits and medicines,
Maintainence and utilities to give to the laymen,
Therefore he obtains offering and supplying.
Slaves and servents as well as fields and houses,
Are given to them and caused them to take and accept,
The non good *bhik□us* and others
Regard him as the master and senior,
Who has less wisdom and cheats with widely learning,
And dislikes those who practise meditation and observe the precepts,
After that the meditationer and precept observer have left,
They fight and quarrel for properties.
The k□atriya learns that and become angry.
He beats and kills the evil *bhik□us*,
And force them to return to the lay life and abandon the dharma clothes,
And bind them and close them in prison.
Therefore the heavenly beings get angry,
And they repeatedly tell each other,
In the land like this,
Under the governing of the Ca□□āla King,
The companions and followers of the evil *bhik□us*,
Damage and destroy the clothes of ka□āya.
They spoil their own land,
And soon they will be defeated and destroyed,

166 比丘 還俗捨法服 繫閉於牢獄 以是諸天瞋 疊共相告語 如是國土中 旃陀羅王

167 治 朋黨惡比丘 毀破袈裟服 自壞己國土 不久當敗亡 墮在阿鼻獄 受苦極長遠

168 於是賢劫中 無脫地獄時 是旃陀羅王 眾聖所厭賤 聽讀檀屍法 諂曲虛詐現 是

169 王多詐偽 速滅己國土 苗稼不成熟 亢旱及水澇 鼠鼠惡象暴 自他國兵起 曜入

170 非常宿 大地普震動 白虹妖星墮 時氣多病疫 焚燒諸聚落 速壞國城邑 剃頭著

171 袈裟 諸佛所加護 一人出家者 天人所供養 唯除諸如來 無有自在者 彼旃陀羅

Fall into the hell of Avīci,
Suffer the torture for extremely lang time,
Within the good eon,
They have no time to get rid of the hell,
That Ca□□āla king,
Is disliked and contempted by the sages.
He listens and reads the methods of dānaśīla[47],
Flattering, crooked he appears false and cheatingly.
The king is much dishonest and spurious.
He will soon destroy his land.
The seedlings and plants do not grow mature;
Heavy drought and floods[48],
Rats[49], mice and evil elephants burst out;
And wars arise from other lands;
The heavenly constellations go disordered,
And on the earth are everywhere earthquake.
The white rainbow appears and comet star falls down,
And at that time there are many diseases and epdemics
The settlements of people are burnt down,
And the land, city and town are quickly damaged,
Those who cut their hair and wear the ka□āya,
will be protected and guarded by the Buddhas
If one single person leaves home,
He will be offered and sustained by the heavenly and human beings.
Only except the Tathāgatas,
There are no one free and omnipotent.
That Ca□□āla King,
Rebukes and punishes the evil *bhik□us*.
[Thus he] damages and spoils the Buddhas of the three worlds,
And the two kinds of pure dharma bodies
His ulcer of afflications are so deep and heavy,
That it is impossible for him to meet the Buddhas.
All the heavenly beings abandon and leave him,
The Ca□□āla King.
Thus the land is spoiled,
And the dharma eyes must be dispelled and extinguished.
Because the heavenly beings abandon and leave,
Thus the land is spoiled.
The three kinds of essence and energy die out,

172 王 謫罰惡比丘 毀壞三世佛 二種淨法身 煩惱瘡深重 難得值諸佛 諸天皆捨離

173 彼旃陀羅王 如是國土壞 法眼當散滅 諸天捨離故 如是國土壞 三種精氣滅 毀

174 滅天宮殿 白法善朋少 黑法惡黨增 於彼濁惡世 無有明智人 所住阿蘭若 樂法

175 安隱住 彼持戒正法 能令多眾信 鬼神敬信故 遮障諸怖畏 增長三精氣 熾然我

176 正法 彼以禪定樂 充滿天宮殿 是故以我法 付諸鬼神王 遮障惡剎利 莫惱我聲

177 聞 國王於持戒 親近常供養 破戒不親供 捨離各隨住 國王不惱彼 持戒及毀禁

And the heavenly palaces and houses are damaged and destroyed,
The good friends of pure Teachings decreased;
The evil parties of dirty Teachings increased.
In that turbid evil world,
There are no persons with bright wisdom,
Those who abide in the place of ara□ya,
Enjoy the Teachings and abide safely and secretly.
They observe the precepts of the correct Teachings,
Which can make many persons believe.
Because of the reverence and blief of the ghosts and gods,
The horror and frightenings are covered and hindered.
The three kinds of essence and energy are increased,
And thus my correct Teachings is glorified,
They rejoice themselves with the dhyāna concentration,
[And the rejoicing] fulfill the heavenly palaces,
Therefore I with my Teachings,
Entrust the kings of ghosts and gods,
To cover and hinder the evil k□atriyas,
And keep them from disturbing my voice-hearers.
The king observes the precepts,
And becomes intimate with and permanently offer and sustain [the *bhik□us*].
Those who break the precepts he do not offer them personally.
Abandoning or leaving [the land] is up to them respectfully.
The king does not disturb them,
Whether they observe the precepts or damage the commandments.
The k□atriya observe the precepts purely,
They all believe and revere.
Vaiśya and brahmans,
Do not disturb the heavenly gods.
The correct Teachings abide for long time,
The pure Teachingss increase permanently.
In that land you might,
Feel as you please and live safely.
If you arouse your minds,
That you live safely on the land everlastingly,
Until the exhaustion of my Teachings,
Do not leave for other lands.
With the method of dānaśīla,

178 剎利淨持戒 彼此皆信敬 毘舍婆羅門 不惱諸天神 正法得久住 白法常增長 汝

179 等於此土 隨意而安住 汝等若發心 此土常安住 乃至我法盡 莫向諸餘國 以檀

180 屍羅法 令多眾歸信 智者能成熟 彼非是希有 於彼惡世時 熾然我正法 遮障惡

181 剎利 此事為希有 慈心常相應 莫打我聲聞 彼二說正法 能救地獄苦 比丘不護

182 戒 國王莫謫罰 汝諸剎利王 莫共沙門鬪 俗人作諸惡 速趣於地獄 軟語向彼二

183 遮除諸惡業 莫以麁穬語 亦莫打治罰 以是國不壞 增長三精氣 正法得久住 佛

Make many persons return and believe,
The wise can be proficient,
Their faults are rare.
In that time of evil world,
They made my correct Teachings glorified
Covered and hindered the evil k□atriya,
Which is arare thing.
Their merciful hearts are in accord permanently.
Do not to beat my voice-hearers,
Those two kinds [of *bhik□us*] expound the correct Teachings,
Which can save the suffering in the hell.
If the *bhik□us* do not protect the precepts,
The king should not rebuke and punish them;
You all k□atriya kings
Should not struggle with the śrama□a;
When the laymen make evil thing,
They will fall into the hell soon,
With soft words tell the two [kinds of *bhik□us*],
Cover and remove the evil actions.
Do not say the rough and crude words,
Also do not beat, penalize and punish them,
Therefore the land will not be damaged,
And the three kinds of essence and energy increase.
The correct Teachings exists for long time,
Buddha's Teachings is glorious and far-reaching.
There are many ones who expound the Teachings,
Can close the three evil ways,
Stop and appease the evil of the world,
And increase the benefits to the heavenly beings.
Therefore the door of nirvā□a can be opened.
And those who are not defiled can enter.
[The power of] bodhisattvas are enchanced,
Just like the the waxing phase of the moon,
Who can make the Six Perfections,
Fulfill the Teachingss of Buddhas.
Therefore all the wise,
And all the present bodhisattvas,
You should abide in that land,
To glorify my correct Teachings;

184 法久熾然 多有說法者 能閉三惡趣 休息世間惡 增益諸天眾 涅槃門得開 無漏

185 者則入 菩薩得增長 猶如明分月 能以於六度 充滿諸佛法 是故諸智者 所來諸

186 菩薩 當住於此土 熾然我正法 冥失道土者 當與正法眼 眾生以六度 成熟於菩

187 提 汝等則成供 三世諸如來 速證菩提果 淨國作導師 大眾皆默然 唯有賢劫眾

188 彌勒為上首 一切皆悉起 合掌而白佛 鹹作如是言 我不詣餘方 護持佛正法 盡

189 我精進力 成熟大菩提 隨於彼時中 應機而說法 欲有留難時 我等不能遮 法欲

To those who lost their land of the Way in the darkness,
You should give them the eye of the correct Teachings.
To the sentient beings with the Six Perfections,
[Thus you] will accomplish the Bodhi,
You should then accomplish the offering of,
All Tathāgatas of the three times;
Quickly realize the fruit of the Bodhi,
In the pure land be a master.
Everyone in the assembly are silent.
Only those of the good eon,
Of them Maitreya is the superior leader,
All stand up together,
Folding their hands and said to Buddha,
All said the following words:
We do not visit other places,
But protect and hold Buddha's correct Teachings,
Exhaust all my power of efforts,
To accomplish the great Bodhi,
Adapt to the time and occasions,
Expound the dharma in responding to the capacity,
If there will be time of difficulties of detaining,
We can not hinder;
And when the Teachings is going to be extinguished completely,
We can also not hinder.

Then the world Honored One told the White-Wise-Child-True bodhisattva Mahāsattva, and said the verse:
Contemplating the bodhisattvas,
Brave and courages holding the torch of wisdom,
Infinite asa□kheya,
[They] come from Buddha's lands of other directions,
With various kinds of good roots treasure,
Returning to the sees of the Buddhas,
With the power of kindness and mercy and expedients,
[They] do not move from Buddha's Teachings.
For that there is no one,
Who can hold my Teachings,
But the bodhisattvas of the good eon,
Are able to hold my Teachings.

190 滅盡時 我亦不能遮 爾時世尊告彼白智童真菩薩摩訶薩而說偈言： 觀此

191 諸菩薩 勇猛執智炬 無量阿僧祇 他方佛土來 種種善根寶 歸依諸佛海 慈悲方

192 便力 於佛法不動 於此無有一 能持我法者 賢劫諸菩薩 堪能持我法 於我滅度

193 後 佛法欲滅時 所有出家者 如無有慚恥 遠離功德智 懈怠不精進 捨道學世業

194 不樂持禁戒 愚癡與俗交 多言復無羞 貪取佛僧物 染著五欲樂 如是比丘等 資

195 生與俗 同疑惑多貪財 邪婬怒嫉妬 見住蘭若者 說其諸過惡 不樂讀誦經 嗜睡

196 多喜鬪 如是等沙門 厭賤禪蘭若 堅著於惡事 自高輕蔑他 沙門及俗人 慳貪不捨

After my Nirvā□a,
When Buddha's Teachings is going to be extinguished,
All those who have left home,
As if they had no feeling of shame and humilation,
[They are] Far from merit, virtue and widom,
Lazy and sluggish and make no efforts.
They abandon the Way but learn the secular professions,
Do not enjoy observing the precepts and commandments.
Stupid and foolish they deal with the laymen,
Talkative and shameless,
Greedy taking the belongings of Buddha's monks,
Are defiled and adhered to the pleasure of the Five Desires.
The *bhik□us* like those,
Have the same necesseties of daily life with the laymen.
They are dubious and greedy for wealth,
Evil, lusty, angry and jealous.
Seeing those who abiding in places of ara□ya,
They speak of their faulties and bad deeds,
They do not enjoy reading and reciting the scriptures,
Are addicted to sleeping and fond of struggling.
The śrama□as like those,
Contempt and disregard those who meditate in the place of ara□ya.
They steadily adhere to the evil things,
And they are arrogant and conceited and disregard the others.
Śrama□as and laymen are,
Stingy and greedy and do not give charity.
They swallow and eat the belongings of Buddha's monks,
Mostly suffer the various kinds of diseases,
Having no mind of kindness and mercy,
And less power but badly enjoy struggling.
Therefore it does not rain from the sky,
So lakes and water areas are completely dried up.
Famine and starvation dominate the world.
The fruits have no flavor,
And it it short of drinks and foods.
They angrily struggle and rob each other.
They make the Ten Non-good Actions of the,
Having less merits and no offering and sustaining;
Their flavor of the dharma is not pure and rich;

197 施 噉食佛僧物 多遭種種病 無有慈悲心 少力惡喜鬬 以是天不雨 潤澤悉枯涸

198 飢饉遍世間 果實無滋味 乏少於飲食 瞋諍相侵奪 造十不善業 少福無供養 法

199 味不純厚 行法心亦薄 疊共作麁想 殺害無慈愍 不孝於父母 亦不供尊長 多修

200 世俗行 疑惑復嫉妬 貪染於邪法 非法無厭足 貪求無厭故 是以久流轉 如是諸

201 國王 及以輔相臣 沙門婆羅門 毘舍首陀羅 樂鬬憎持戒 互共相謗毀 南方邊夷

202 國 王名波羅帝 百千諸軍眾 士將共圍繞 西方邊夷國 有王名百祀 亦將百千軍

Their mind of the practising the Teachings also poor.
Together repeatedly they make the stupid thoughts,
Killing and harming others without kindness and mercifulness.
They have not filial love to their parents,
And also do not offer the honored ones and seniors
More they practise the secular deeds,
Suspicious and dubious and jealous,
Greedy and defiled by the evil Teachings,
And [enjoy] the non Buddhist dharma without satisfaction,
Because of their avarice without satisfaction,
Therefore it is spread and transferred for long time,
The kings like those,
With their chancellors and ministers
*Śrama□as* and *Brahmans*,
*Vaiśya* and *śūdra*,
Enjoy struggling and hate observing the precepts,
Together they slander and damage themselves each other.
In the south there is a boundary barbarian country,
The king is called Boluo King.
He has hundred thousand soldiers,
and generals who together surround him.
In the west there is a boundary barbarian country,
The king is called Hundred Sacrifice.
He has also hundred thousand soldiers,
Who in front and behind together surround him.
In the north there is a boundary barbarian country,
The king is called Goodwill Śākya.
Soldiers and generals with the military followers,
Who also hundred and thousand surround him.
In the east there is a Kauśāmbī country,
Whose king is called Great Army ,
Dependents and follower are hundred and thousan of,
who surround him and protect and guard him,
King Great Army has a son,
Whose name is Bad-looking.
As he was born he wore a armor on his body,
Holding a knife in his hand and blood coated on his body.
With big power and strong body,
Was he born from his mother's womb,

203 前後共圍繞 北方邊夷王 名善意釋迦 士將諸嘗從 圍繞亦百千 東方睒彌國 王

204 名為大軍 眷屬百千眾 圍繞而侍衛 大軍王有子 名之為難看 生時身著鎧 把刀

205 血塗身 大力體堅固 而從母胎生 是時長者等 大臣五百人 同時俱生子 身亦著

206 鎧甲 執刀血塗身 皆從母胎生 是日於其國 天龍降血雨 五百長者子 難看同處

207 養 難看年七歲 父母授其位 邊夷三惡王 又至北天竺 破國煞害人 怨讐妬女色 積

208 財以火燒 瞋怒向中國 邊夷王等來 毀破佛塔寺 煞害諸眾僧 劫奪佛僧物 病瘦

209 諸比丘 不能走逃避 少壯強力者 散走於他方 諸餘比丘等 少年初出家 未善學

At that time the seniors an so on,
And the ministers five hundred person,
Have got their sons born,
Who also wore the armors,
Holding knives in hand and blood coated on the bodies,
All were born from their mothers' womb.
On the day in that land,
It rained blood from the heavenly dragon.
The sons of the five hundred seniors,
Were raised in the same place with Bad-looking.
As Bad-looking was seven years old,
His parents[50] bestowed him the throne,
The three evil kings of the boundary barbarian countries,
Came to the north India again.
They attack the land and kill people,
Resenting enemy are jealous with the women,
And the stored wealth are burnt with fire.
Angrily and furious they approach to the middle kingdom.
The boundary barbarian kings come.
They damage and break the Buddhist pagodas and temples,
Kill the monks,
Rob and snatch the belongings of the Buddha's monks.
The ill and weak monks,
Can not run away and escape from them.
The young and strong and powerful monks,
Were scattered in other places.
The other *bhik□u*s and so on,
Who have just left home at young age,
Have not well learnt the precepts,
And do not possess the deportment of the Teachings.
They run and escape everywhere,
Were bullied and humiliated in the place where they are.
Damaged and disgraced, beated and cursed,
They undertook from the sufferings and distress constantly.
The three boundary barbarian kings,
Together with their soldiers,
Gradually they come near to Kauśāmbī.
For twelve years they have fighted,
The three kings and their followers,

210 戒者 威儀法不具 處處走逃避 隨至被欺陵 毀辱而打罵 恒受諸苦惱 彼三邊夷

211 王 及與諸軍眾 漸詣拘睒彌 十二年中鬪 三王及眷屬 難看王殺盡 統領閻浮提

212 而作一蓋王 於後大悔恨 我獲無量罪 頗有明比丘 當於我懺悔 說言有三藏 父

213 名為火施 種姓常清淨 是大婆羅門 子名失師迦 高才智勇博 釋子中大名 今住

214 波梨國 時王即遣使 請彼三藏來 為王演正法 令王生敬信 我於十二年 戰鬪大

Were all killed by the king Bad-looking,
So he united the Jambu-dvīpa,
And becomes the king of the unification,
After that he feels great regret and sorrow,
I obtain infinite crimes.
Is there any *bhik□u* of wisdom?
To him I should repent and confess.
Someone said there is a Three Canon master,
Whose father is called Fire-donator,
His family and caste is pure and clean everlastingly.
It is namely great Brahman.
His son is called Śi□ya[51],
And he has highly ability and full of wisdon and bravery,
Having a great name in the Buddhists.
Now he lives in the Pāla Kingdom.
Then the king sends a messenger at once,
To invite the master of the Three Canons to come
[He] shows the correct Teachings to the king,
To cause the king arise reverence and belief.
I have since twelve years,
Struggled and fought and done great[52] crimes,

[1] From 1. to 10. about the ten kinds persons the scriptural texts are quoted from T13, no.397, p353c-354a.

[2] The character“人”is not found in T.

[3] *upāsaka*, *upāsikā* are layman and laywoman.

[4] The character “佛” should be“说”.

[5] T13, no.397, p354b.

[6] Compare T13, no.397, p355b. Two characters more are found in T.

[7] Original scripture of the texts above are not identifiable. The followings are from T13, no.397, p355c.

[8] In T it is“ 女” instead of“人”.

[9] It means ”extremely stinky hungry ghost “.

[10] In T it is“陋” instead of“漏”.

[11] From line no.37 see T13, no.397, p355c.

[12] The following characters are not carved : “合掌向佛恭敬礼拜。同时一音作如是言：“我等皆已承佛威神。迭相谢过。迭相住於慈心，忍心，怜悯心，无怨心，地诤讼心。我等一切今当亦复谢过。如来应正遍知。我等昔来“.

[13] From line no.44 to no.49 see T13, no.397, p358c-359a.

[14] T13, no.397, p359a.

[15] In T it is“福德智慧” instead of“智慧福德”. See T13, no.397, p358.

[16] T13, no.397, p359a.

[17] T13, no.397, p359a-b.

[18] T13, no.397, p359b.

[19] The characters “二由减破戒、无戒两种比丘……” are not found in T.

[20] The character “便” is not found in the carved text.

[21] From 20. to 23. see T13, no.397, p359b-c.

[22] Compare 2.4.10.10. of the second text by Xinxing.

[23] For 24. and 25. see T13, no.397, p359c.

[24] In T it is “頌” instead of “訟” here.

[25] From 26. see T13, no.397, p363a, and in T it is all “次五百年” instead of “后五百年”.

[26] In T it is “以” instead of “已”.

[27] The character“寶”is not found in T.

[28] The character“為”is not found in T.

[29] The character“為”is not found in T.

[30] In T it is “铁” instead of “鎦”.

[31] In T it is “腊” instead of “鑪”.

[32] The character“以”is found in T before “為”.

[33] In T it is “净持” instead of “清净”.

[34] The character“以”is found in T before “為”.

[35] The character“比丘”is found in T after “汙戒”.

[36] In T it is “字” instead of “为”.

[37] In T it is “为 物” instead of “以为”.

[38] From 26. to 29. see T13, no.397, p363a-b.

[39] The characters about the number of Buddhas in more that sixties countries from“东弗提婆八万佛现” to “新陀跋持國二十五佛現。佛言。諸仁者。如是等佛於此四天下國土城邑村落山林處處而現我今神力之所加故“ is not carved here. See T13, no.397, p374b.

[40] The character“多少与佛一种”is not found in T. They may refer to the omitted characters in the aboce note.

[41] In T it is “冤” instead of “怨”.

[42] It is carves possibly as “恐” instead of “怖”.

[43] The character“汝”is not found in T after “今“.

[44] For 30. see T13, no.397, p374.

[45] The two verses “沙門剎利王 激動相瞋惱“ seem not to be continuously with the context curiously.

[46] In T it is “飢饉極儉短” instead of “飢饉復短”. See T13, no. 397, p. 376a.

[47] The Term “檀屍羅“ is not found in any other sutras. It is possibly the phonetic transliteration of dānaśīla, the precept of giving.

[48] In T it is “潦” instead of “澇”.

[49] It is carved as “蟲” instead of “鼩” in T.

[50] In T it is “王” instead of “母”.

[51] Disciple.

[52] 30. is the whole verse from T13. no.397, p375b-380b. The extant is only until p377c.

0 七階佛名經一卷 信行禅师撰

十方三世諸佛當證知：弟子某甲等，為一切

1 眾生，觀一切三寶；為一切眾生，禮一切三寶；為一切眾生，供養一切三寶；為一切眾生，於一切三寶前行

2 道；為一切眾生，於一切三寶前懺悔；為一切衆生；作佛像、轉經、供養眾僧；供養一切眾生，行六波羅蜜，四

3 攝四無量等。一切行已集、當集。現集一切善根，以此善根，願令：一切三塗眾生，一切貧窮眾生，一切生老

4 病死眾生，一切獄囚繫閉眾生，一切破亡流徙眾生，一切不自在眾生，一切邪見顛倒眾生等，悉得離苦

5 解脫，捨邪歸正發菩提心，永除三障。常見一切諸佛菩薩及善知識，恒聞正法福智具足，一時作佛。 又以

6 此善根，願令一切眾生，皆悉上品往生一切淨土。先證無生忍，然後度眾生 又以此善根，願令一切三寶，

Sutra of Buddha Names of Seven Rosters[1], One Scroll, Compiled by Meditation Master Xinxing

The Buddhas of the ten directions and three worlds should witness and know:
the disciples Somebody and so on, for the sake of all sentient beings, contemplate all Three Treasures; For the sake of all sentient beings, revere all Three Treasures; For the sake of all sentient beings, offer and sustain all Three Treasures; For the sake of all sentient beings, circumambulate before all Three Treasures; For the sake of all sentient beings, confess and repent before all Three Treasures; For the sake of all sentient beings, make Buddha statues, turn the [wheel of] sūtras, offer and sustain the monks; Offer and sustain all sentient beings, practice the Six Pāramitās, the Four Winning Over, the Four Immeasurable Minds and etc. All practices which are already gathered or to be gathered. Now gathering all the good roots, and with those good roots, we vow that, all sentient beings in the Three Evil Ways; all poor and destitute sentient beings; all sentient beings of birth, old, illness and death; all sentient beings in prisons and jailed; all sentient beings of moving and on the way; all sentient beings of feeling no freedom; all sentient beings with evil thoughts and delusions; all sever from the suffering and are salvated, abandon the evil and return to the good, arouse the mind to enlightenment, eliminate the three defilements eternally, permanently see all Buddhas, bodhisattvas and Genuine Teachers, perpetually hear the correct Law, are fully bestowed with the meritorious wisdom, become Buddha at one time.
Further with those good roots, we vow that, all sentient beings, all are reborn in higher class in all Pure Lands. First realize the enlightenment of cognizant of complete non-arising, and then salvate the sentient beings.
Further with those good roots, we vow that, all Three Treasures, all lands and territories become safe and peaceful forever, are not be broken, not be damaged,

7 一切國土常得安隱，不破不壞，四方寧靜兵甲休息。龍王歡喜，風調雨順，五穀熟成，萬民安樂。六時禮

8 拜佛法大綱：晝三夜三各嚴香華，入塔觀像供養行道禮佛。平旦及與午時，並別唱五十三佛，餘皆總唱；

9 日暮初夜，並別唱三十五佛，餘階總唱；半夜後夜，並別唱二十五佛，餘階總唱。觀此七階佛如在目前，思

10 惟如來所有功德，廣作如是清淨懺悔。　　七階佛名經一卷

peaceful and serene, and the soldiers and their weapons have their rest; the dragon king is pleased [to bring] seasonable weather with gentle breeze and timely rain, and the Five Cereals grow mature and the common people feel safe and happy. [2]
A stretch of revering and worshipping Buddha and Dharma in the Six Times [of day and night]: Three times in the day and three time in the night respectly adorn with incents and flowers, enter the pagoda, contemplate the Buddha statue, circumambulate and worship the Buddha statue. On the morning and in the noon chant the names of the Fifty-three Buddhas respectly, and then chant those of the other stages together; In the evening and early night chant the names of the Thirty-five Buddhas respectly, and then chant those of the other stages together; In midnight and late night chant the names of the Twenty-five Buddhas respectly, and then chant those of the other stages together. Contemplate the Buddhas of the Seven Stages as if they were before the eyes, think over all the merits and virtues of Tathāgata, extensively make such clean and pure confession and repentance.

Sūtra of Buddha  Names of Seven Stages, One Scroll

[1]The text is reserved in *Ji zhujing lichanyi* 集諸經禮懺儀 compiled by Zhisheng 智升(7th – 8th century) as *Zhouye liushi fayuan fa* 晝夜六時發願法 (The Method of Arousing the Vow in the Six Times of Day and Night). The underlined characters are added by the transcriber according to the manuscripts from Dunhuang ( no. 8309, 8310 in Beijing National Library and S. 2360 七階佛名經 )

[2] In T there are 51 characters more between 萬民安樂 and 六時禮拜 are found as following: "禮佛功德。廣大如法界。究竟如虛空。盡未來際供養一切三寶。終無有休息。隨意靜默量時任唱。初夜半夜後夜午時平明日沒。唱靜". See T47, no. 1982, p465.

# Untersuchung chinesischer Gesteinsproben der Jinchuanwan Grotte, Provinz Shaanxi, China

# Examination of the stone samples from the Jinchuanwan grotto, in the province Shaanxi, China

**Rolf Snethlage, Erwin Emmerling, Mathias Kocher, Vojislav Tucic, Martina Klukas and Melanie Eibl**

**Technische Universität München, Lehrstuhl für Restaurierung, Kunsttechnologie und Konservierungswissenschaft**

**Bayerisches Landesamt für Denkmalpflege, Zentrallabor**

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## Einleitung

Die Maßnahmen zur Konservierung und Restaurierung der Jinchuanwan Grotte werden im Rahmen des China-Projekts durch das Bayerische Landesamt für Denkmalpflege und die Technische Universität München unterstützt. Es wurden in China entnommene Gesteinsproben zur Untersuchung an das Bayerische Landesamt für Denkmalpflege gegeben, um daran 2008/09 die Gesteinskenndaten zu ermitteln, Festigungsversuche durchzuführen sowie die Werte der gefestigten Steine mit den Werten der unbehandelten Steine zu vergleichen. Dieser Bericht gibt einen Überblick über die Messergebnisse und die dazu angewendeten Untersuchungsmethoden.

### Geografische Lage

Die Grotte befindet sich ca. 80 km nord-nordwestlich von Xi'an und liegt westlich des Dorfes Jinchuanwan („Goldflüsschenbucht") in einem Tal am Fuße eines der umgebenden Berge, oberhalb eines kleinen Flusses.

Die Anlage ist in eine bestehende Felsformation eingearbeitet. Der Grotteneingang weist Richtung Norden. Er ist heute durch eine moderne Mauerung, der vermutlich als Witterungsschutz angebracht wurde, teilweise verschlossen.

## Introduction

The conservation and restoration of the Jinchuanwan grotto are supported by the China project in cooperation with the Bayerisches Landesamt für Denkmalpflege and the Technische Universität München. The rock samples taken in China were sent to be analysed by the Bayerische Landesamt für Denkmalpflege to determine the rock features 2008/09, to do consolidation tests and as well to compare the values of the consolidated stones to the values of the untreated stones. This report gives an survey of the results and the used laboratory analysis.

### Geographical Position

The grotto is located 80 km north-north-west from Xi'an, to the west of the village Jinchuanwan ("golden creek bay") in the valley. at the foot of one of the surrounding mountains, above a small river

The grotto is part of an existing rock formation and built in this. The original entrance together with the northern wall has been destroyed long time ago and was rebuilt with grey bricks recently, supposable as a weather protection.

**Abb. 1:** Kartenausschnitt: Weg von Xi'an nach Jinchuanwan / ***Fig. 1:*** *Map with the route from Xi'an to Jinchuanwan*

**Abb. 2:** Außenaufnahme der Grotte mit moderner Vormauerung / ***Fig. 2:*** *Exterior view with modern wall*

## Die Grotte

Die Grotte ist ca. 10 m breit, bis zu 10 m tief und ca. 7,1 m hoch. Die große Buddhastatue an der Südwand ist eine Rekonstruktion der neuesten Zeit. Die ursprüngliche Buddhafigur wurde während der Kulturrevolution 1970 teilweise, die seitlichen Assistenzfiguren vollständig zerstört. In die Wandflächen der Grotte sind Surentexte der Lehre des Meisters Xinxing (540–593) in die Steinwände gemeißelt. Ursprünglich waren es ca. 160.000 Zeichen, heute sind davon noch etwa 60.000

## The Grotto

The grotto is about 10 m wide and long and 7.1 m high. The big Buddha statue on the south wall is a recent reconstruction. The original statue was partially destroyed during the Culture Revolution in 1970, the assistance statues to the sides of the big Buddha were completely destroyed. In the wall surfaces of the grotto Sutra texts of the doctrine of master Xinxing (540–593) are carved, approx. 160 000 signs, today there are about 60 000 left. The size of the signs is about 1.5

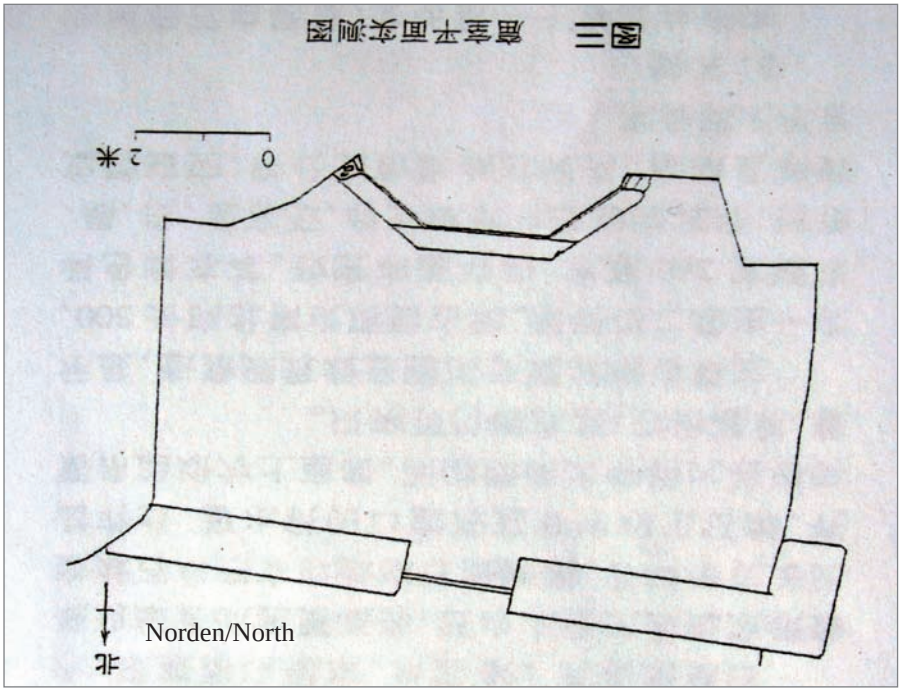



**Abb. 3:** Grundriss der Grotte, an der Südwand befindet sich die große Buddhastatue / ***Fig. 3:*** *Ground view, the Buddha is situated in front of the south wall*

**Abb. 4:** Innenansicht der Grotte mit Blick auf die Südwand / ***Fig. 4:*** *Interior view to the south wall*

erhalten. Die durchschnittliche Höhe der Zeichen beträgt nur 1,5–1,8 cm. Insgesamt sind acht Sutras, je vier auf der östlichen und westlichen Seitenwand aufgezeichnet. Die in der Grotte aufgezeichneten Texte wurden anhand einer Stifterinschrift auf 662 bis 670 datiert. Die Texte wurden durch Zhao Zhou nach der Transkription durch Zhang Zong ins Englische übersetzt. Dieser Übersetzung sind die Angaben zur Grottenanlage entnommen.

to 1.8 cm. Altogether eight Sutras can be found, four on the eastern and four on the western side wall. The inscriptions original are from the period from 662 to 670, according to the founder's inscription in the grotto. The texts were translated by Zhao Zhou according to the transcription by Zhang Zong into English. This information is taken from the translation.

## Grundlagen

### Gesteinsaufbau

Jedes Gestein setzt sich aus mineralischen Komponenten zusammen, die entsprechend ihrer gegenseitigen Bindung das Hohlraumgefüge des Gesteins prägen. Eine qualitative und quantitative Gesteinsbeschreibung kann aufgrund der primären petrografischen Merkmale wie Mineralbestand und Gefüge erfolgen. Anhand dieser Grundmerkmale lassen sich in erster Näherung auch Materialeigenschaften wie beispielsweise mechanische und thermische Kennwerte ableiten.

Die petrografischen Merkmale eines Gesteins (Mineralien, Gefüge und Chemismus) ermöglichen dessen eindeutige Klassifizierung. Der Mineralbestand liefert eine qualitative und quantitative Beschreibung der Gemengteile eines Gesteins, also eine Aufzählung der im Gestein vorhandenen Mineralarten mit der Angabe des jeweiligen Volumenprozentanteils im Gestein. Mineralarten, die mit mehr als 10 Vol.% am Aufbau des Gesteins beteiligt sind, werden als Hauptgemengteile bezeichnet, in Abgrenzung zu den Nebengemengteilen

## Basics

### Structure of Rocks

Every rock is made up of various mineral components, which influence the stone structure due to their linkage. The qualitative and quantitative description of stone can be made based on the primary petrographic characteristics like mineralogical composition and structure. Based on these basic characteristics, material specific values like mechanical and thermal features can be derived.

The petrographic characteristics of rocks (minerals, structure and chemism) allow them to be unmistakably classified. The mineral composition provides for a qualitative and quantitative description of the rock's components, in other words a listing of the mineral types and the volume percent of each mineral. Major components are those minerals which comprise more than 10 vol.% of the rock. Minor components comprise less than 10 vol.% and accessory components less than 2 vol.%.[1] The stone structure is characterised by texture and pore structure, whereby the pore structure

(< 10 Vol.%) und den akzessorischen Gemengteilen (< 2 Vol.%).[1]

Das Gesteinsgefüge wird durch die Beschreibung von Richtungsgefüge und Hohlraumgefüge charakterisiert, wobei das Hohlraumgefüge durch Porenvolumen, Porengröße, Porenform, Porenverteilung und Porenoberflächen beschrieben werden kann. Die Ermittlung dieser Kenndaten ermöglicht nicht nur eine Klassifizierung des Gesteins, sondern erlaubt auch Aussagen über Transportvorgänge von gasförmigen und flüssigen Phasen im Gestein, Abläufen von Verwitterungsprozessen, sowie Stabilität des Gesteins. Um das Einbringen von Schutzmitteln in den Porenraum gezielt zu steuern, und chemische Festigungs- und Schutzmaßnahmen durch Überwachung und Nachweis der Wirksamkeit zu kontrollieren, ist die Kenntnis des Hohlraumgefüges von Bedeutung. Unter Gefüge werden dementsprechend alle räumlichen Aspekte der Gemengteile eines Gesteins und deren räumliche Anordnung zueinander verstanden. Die Struktur (Korngefüge) bezeichnet die räumlichen Merkmale der einzelnen Mineralkörner, wogegen die Textur, auch als Richtungsgefüge bezeichnet, die räumliche Anordnung der Mineralkörner zueinander beschreibt. Das Korngefüge wird durch absolute und relative Korngröße, die Form der Gemengteile (Tracht und Habitus der Mineralkörner), sowie den Grad der Ausbildung von arttypischen Kornumrissen beschrieben.[2]

## Verwitterung

Jedes Gestein ist als Naturwerkstoff äußeren Faktoren, wie Klima, Biosphäre und Schadstoffen, ausgesetzt. Physikalische, chemische und biologische Verwitterungsprozesse tragen zu einer Veränderung der Gesteinseigenschaften bei. Die meisten dieser Mechanismen laufen überwiegend im oberflächennahen Porenraum ab, weshalb das Verwitterungsverhalten eines Gesteins maßgeblich von dessen Porositätskennwerten geprägt ist. Gleichzeitig bewirkt jeder Verwitterungsprozess eine Veränderung des Porenraums. Das Hohlraumgefüge eines Gesteins ist damit ein das Verwitterungsverhalten prägendes Gesteinsmerkmal. Daneben sind die Beständigkeit der Mineralkomponenten, sowie die Art der Kornbindung von Bedeutung. Eine Charakterisierung des Verwitterungszustandes erfolgt demnach über die Ermittlung der Gesteinsparameter, anhand derer die Beurteilung verwitterungsbedingter Veränderungen möglich ist.

is described by pore volume, pore size, pore form, pore distribution and the inner surface of the pores. The identification of these features allows not only classification of the stone but also determination of transport processes of gaseous and liquid phases, weathering processes as well as the stability of the stone. In order to control the consolidation treatment and to prove effectiveness, knowledge about the structure is imperative. The term structure includes all steric aspects of the components and their steric relation to one another. The structure describes the steric aspects of the single mineral grains, whereas the texture describes the steric arrangement of the mineral grains. The structure is described by absolute and relative size of the grains, the habitus of the components and the degree of growth of typical grain shapes.[2]

## Weathering

Every stone, as a natural material, is exposed to factors like climate, biosphere and pollutants. Alteration due to physical, chemical and biological weathering processes result in a modification of the rock's characteristics. Most of these mechanisms occur in the surficial pore space, and so the alteration of a stone is significantly affected by its porosity values. At the same time, every weathering process effects a change in the pore space. Thereby, the stone's structure also affects its durability. In addition, the durability of the single minerals, as well as the linkage of the grains are of importance. The state of weathering can be evaluated by determining the stone parameters, which enables the assessment of changes caused by weathering.

### Ziel der Steinkonservierung

Im Rahmen der Steinkonservierung soll die Dauerhaftigkeit eines Natursteins verbessert werden. In der Regel muss hierzu das verwitterte Gesteinsgefüge zusätzlich stabilisiert (Gesteinsfestigung) und die kapillare Wasseraufnahme reduziert (Hydrophobierung) werden. Die Einlagerung von Schutzmitteln verändert grundsätzlich das physikalische Verhalten von Gesteinen. Sowohl zur Charakterisierung des Verwitterungszustandes als auch zur Beurteilung und Überprüfung des Erfolgs einer Festigungs- oder Hydrophobierungsmaßnahme ist die Gesteinskonservierung begleitende Laboruntersuchung von großer Bedeutung, da sie unter anderem dazu dient, die für das Erreichen der Restaurierungsziele geeigneten Konservierungsmaterialien und Methoden festzulegen. Die Analyseergebnisse gewährleisten konkrete Angaben zu Material, Anwendungsarten und -zeiten, sowie zur Wirksamkeit einer Konservierungs- bzw. Restaurierungsmaßnahme.[3]

Im Folgenden werden die in der Praxis üblichen Untersuchungsmethoden und ihre Bedeutung im Rahmen einer Konzepterstellung für eine Steinkonservierung vorgestellt, bevor die Vorgehensweise bei der Untersuchung des Sandsteins der Jinchuanwan Grottenanlage erläutert und die Analyseergebnisse beschrieben und bewertet werden.

## Laboruntersuchungen

### Feuchtekennwerte

Mit Ausnahme der Temperaturverwitterung müssen alle in einem Gestein ablaufenden Verwitterungsprozesse in Zusammenhang mit Wasser betrachtet werden. Die auch als hygrische Eigenschaften bezeichneten Parameter sind für jedes Gestein charakteristisch und werden durch Sorptions-, Desorptions- und Permeationsvorgänge definiert. Von grundlegender Bedeutung ist also im Allgemeinen das Verhalten des Wassers im Gestein, welches insbesondere durch den Faktor Porenraum gesteuert wird. Es existieren vielschichtige Beziehungen zwischen Porenstruktur und Feuchtetransport, sodass über die Bestimmung der Wasseraufnahme auch Aussagen zur Porosität eines Gesteins getroffen werden können.

Sämtliche Kenngrößen des Feuchtetransports und der hygrischen Dehnung gehören zu den Basisdaten, die vor jeder Konservierungsmaßnahme ermittelt werden sollten.[4]

### Objective of Stone Conservation

The goal of stone conservation is to improve the durability of natural stone. Usually the altered stone structure has to be additionally stabilised and the capillary water absorption reduced. The application of the consolidants changes the stone's physical behaviour. Scientific analyses are of great importance, not only to describe the state of weathering, but also to determine the appropriate consolidation products and methods, as well as to document the success of consolidation treatments.[3]

The standard methodology and its significance in the field of stone conservation will be described subsequently, followed by a detailed description of the examination of the Jinchuanwan sandstone, including the presentation of the results of the study.

## Laboratory Analysis

### Hygric Values

With the exception of weathering caused by temperature changes, all the weathering processes within the stone are connected to the presence of water. Every stone has specific hygric parameters which are defined by sorption, desorption and permeation processes. The behaviour of water in stone, which depends upon the pore space, is of significant importance. Different correlations between pore structure and hygric transport exist so that the degree of porosity can be defined according to the amount of water absorption.

All hygric transport and hygric expansion values are part of the basic data that must be gathered before consolidation treatment.[4]

*Porosity*

All physical and mechanical attributes of the material depend significantly upon the pore system.[5] The pore structure is of central importance regarding weathering processes and consolidation treatments. The pore structure is influenced by the porosity (volume percent of the pores), as well as size and shape of the pore spaces (pore structure).

The pore system is very complex, requiring varying classifications. A basic subdivision can be made by characterising open and closed pores. Open pores interact with the surrounding atmosphere, whereas closed pores are completely isolated. Porosity is the ratio of all pores in the stone to its total volume, whereby the amount of pores (n) is the proportion (%) of spaces filled with liquids or gases.[6]

*Porosität*

Alle physikalischen und mechanischen Eigenschaften des Materials hängen in entscheidendem Maße vom Porensystem ab.[5] Nicht nur hinsichtlich der Verwitterungsprozesse kommt der Porenstruktur zentrale Bedeutung zu, auch für Maßnahmen wie Steinfestigung oder Hydrophobierung sind die Beziehungen zwischen Porenstruktur und Feuchtetransport entscheidend. Das Porengefüge wird geprägt durch die Porosität (Volumenanteile der Poren) sowie Größe und Gestalt der einzelnen Hohlräume (Porenstruktur).

Das Porensystem ist sehr komplex aufgebaut, weshalb je nach Fragestellung unterschiedliche Klassifikationsschemata Anwendung finden. Eine grobe Unterteilung kann durch die Charakterisierung von offenen und geschlossenen Poren erfolgen, wobei offene Poren mit der umgebenden Atmosphäre in Verbindung stehen, wogegen geschlossene Poren vollständig isoliert sind. Als Porosität wird das Verhältnis aller im Gestein vorhandenen Hohlräume zum Gesteinsvolumen bezeichnet, wobei der Porenanteil (n) entsprechend der angeführten Formel den prozentualen Anteil der mit Flüssigkeiten oder Gasen gefüllten Hohlräume im Gestein bezeichnet.[6]

$$n = \frac{V_P}{V_g} \cdot 100\ [\text{Vol.\%}] = \frac{V_P}{V_S + V_P} \cdot 100\ [\text{Vol.\%}]$$

$V_p$ = Porenvolumen
$V_S$ = Feststoffvolumen
$V_g$ = Gesamtvolumen

Die Gesamtporosität umfasst alle Hohlräume eines Gesteins unabhängig davon, ob es sich um geschlossene oder offene Poren handelt. Sie ist also die größtmögliche Porositätskenngröße, die nach DIN 52102 über die Formel (Reindichte - Rohdichte) / Reindichte berechnet wird. Der effektive oder offene Porenraum wird durch die Ermittlung der Wasseraufnahme im Vakuum definiert.

Die einzelnen Poren treten in unterschiedlicher Größe auf, weshalb die Porengröße ein weiteres Klassifikationsmerkmal ist. Die Charakterisierung des Porenraums kann mittels unterschiedlicher Analysemethoden erfolgen. Das klassische Verfahren ist hierbei die lichtmikroskopische Untersuchung von Gesteinsdünnschliffen. Bei gleichzeitigem Einsatz der Bildanalyse können Porengefüge, Porengrößen sowie Porenform quantitativ bestimmt und statistisch ausgewertet werden. Es werden aber nur die im Mikroskop sichtbaren Poren erfasst. Das meist angewandte indirekte Messverfahren in diesem Zusammenhang ist die Quecksilberporosimetrie, da durch diese Methode der größte Teil des im Gestein auftretenden Porenraumes messtechnisch bestimmbar ist. Die Kennwerte werden in Abhängigkeit von gängigen Porenmodellen rechnerisch ermittelt, weshalb allerdings keine Aussagen zur realen Porenform zu treffen sind. Mittels dieses

$$n = \frac{V_P}{V_g} \cdot 100\ [\text{Vol.\%}] = \frac{V_P}{V_S + V_P} \cdot 100\ [\text{Vol.\%}]$$

$V_p$ = pore volume
$V_S$ = volume of solids
$V_g$ = total volume

The total porosity includes all pores in a stone regardless of whether they are open or closed pores. Therefore, it is the largest possible porosity value that can be calculated according to the DIN 52501 formula (particle density - bulk density) / particle density. The actual pore space is defined by determining the water absorption in a vacuum.

The various pore types have various sizes. Size is therefore another method of classification. There are various methods of analysing pore spaces. The classic method is microscopic analysis of thin sections of stone. By parallel use of image analysation, pore structure, size and form can be quantitatively determined and statistically interpreted. Only the pores visible under a microscope are taken into consideration. The most frequently used indirect measuring method in this case is the mercury porosimetry; the method which allows the largest amount of pore space in the stone to be determined. The values are calculated using standard pore models, whereby the real pore form cannot be analysed. Using this method, the distribution of pore spaces in relation to certain pore radii ranges can be depicted.

The radius of the pore determines the pressure needed to inject the mercury. Radius and volume of the specific pore group can be determined by the pressure used and the amount of mercury injected.[7] However, it must be taken into account that pore radii are pore penetration radii, so that the measurement may deviate from the actual pore size distribution. A general classification of the pore groups is listed in table 1.

The classification according to IUPAC and DIN 66131 is not solely used for rocks. Therefore this report uses the architectural method of classification for evaluation of the analytical results.

In addition to the total porosity, the distribution of pore sizes has a significant effect on the physical property of stone. Compression strength, tensile strength and water absorption of a stone mainly depend upon its absolute porosity, while hygric dilatation for example is more influenced by pore size distribution.

Messverfahrens kann neben der offenen Porosität auch die Verteilung des Porenraumes auf bestimmte Porenradienbereiche dargestellt werden.

Je nach Porendurchmesser wird zum Eindringen des Quecksilbers in die Poren ein bestimmter Druck benötigt. Aufgebrachter Druck und Menge des eingebrachten Quecksilbers lassen auf Radius und Volumen der jeweiligen Porengruppe schließen.[7] Es ist jedoch immer zu berücksichtigen, dass es sich um Poreneintrittsradien handelt, weshalb sich unter bestimmten Umständen eine Abweichung zur realen Porengrößenverteilung ergibt. Eine allgemeine Einteilung der Porengruppen liefert Tabelle 1.

Die Klassifizierung nach IUPAC und DIN 66131 bezieht sich nicht ausschließlich auf Gesteine. Deswegen wird im Rahmen dieses Untersuchungsberichts die Klassifizierung nach bauphysikalischen Aspekten bei der Auswertung der Analyseergebnisse herangezogen.

Neben der Gesamtporosität hat die Verteilung der Porengrößen einen entscheidenden Einfluss auf die physikalischen Eigenschaften eines Gesteins. Während Druckfestigkeit, Zugfestigkeit und Wasseraufnahme eines Gesteins in erster Linie von dessen absoluter Porosität abhängen, ist die hygrische Längenänderung beispielsweise von der Verteilung der Porengrößen abhängig.

*Wasseraufnahme*

Die Bestimmung der Wasseraufnahme ermöglicht Aussagen zur Porosität eines Gesteins. Darüber hinaus kann auf diese Weise nach einer Konservierungsmaßnahme nachgewiesen werden, inwiefern sich durch die Behandlung die Wasseraufnahme eines Gesteins verändert hat. Die Ermittlung der Wasseraufnahme und Porosität erfolgt nach der archimedischen Methode, bei der drei unterschiedliche Gewichtsbestimmungen an der Gesteinsprobe vorgenommen werden:[9]

1 Wägung im trockenen Zustand mit luftgefüllten Poren ($m_1$)
2 Wägung im wassergesättigten Zustand mit vollständig wassergefüllten Poren ($m_2$)
3 Wägung im wassergesättigten Zustand unter Wasser ($m_3$)

Die Porosität (n) ergibt sich rechnerisch aus der Gleichung:

$$n = \frac{(m_2 - m_1)}{(m_2 - m_3)} \cdot 100 \text{ [Vol. \%]}$$

**Tabelle 1:** Klassifizierung der Porengrößen nach IUPAC und DIN 66131 bzw. in der bauphysikalischen Literatur / ***Table 1:*** *Classification of pore size according to IUPAC, DIN 66131 and architectural literature*

| **Classification** | **Radius (IUPAC und DIN 66131)** | **Radius (architectural)[8]** |
|---|---|---|
| Macropores | > 0.05 µm | > 100 µm |
| Mesopores | 0.002–0.05 µm | 0.1–100 µm |
| Micropores | < 0.002 µm | < 0.1 µm |

*Water Absorption*

The evaluation of water absorption allows the determination of the porosity of stone. This evaluation additionally allows determination of how water absorption changes after conservation treatments are applied. Water absorption and porosity are determined using the Archimedes method, for which three different methods of weighing are used:[9]

1 Weighing while dry with air in the pores ($m_1$)
2 Weighing while saturated with water, with pores full of water ($m_2$)
3 Weighing while saturated with water while under water ($m_3$)

The porosity (n) can than be calculated using the equation:

$$n = \frac{(m_2 - m_1)}{(m_2 - m_3)} \cdot 100 \text{ [Vol. \%]}$$

Die Wasseraufnahme unter Atmosphärendruck ist die maximal mögliche freiwillige Wasseraufnahme eines Gesteins. Ihre Bestimmung erfolgt in Anlehnung an Prüfvorschrift DIN-EN 13755 (früher: DIN 52103). Dabei wird eine bei 70°C getrocknete und anschließend auf Zimmertemperatur abgekühlte Probe über 48 Stunden in destilliertem Wasser gelagert, bevor durch Wägung die dabei aufgenommene Wassermenge ermittelt und auf die Trockenmasse bezogen in Prozent [Masse%] angegeben wird. Zusätzlich erfolgt die Bestimmung der Wasseraufnahme im Vakuum. Die getrockneten Proben werden evakuiert und in diesem Zustand für 48 Stunden in destilliertem Wasser gelagert, bevor durch Wägung die aufgenommene Menge Wasser bestimmt wird. Der Sättigungswert ist der Quotient aus Wasseraufnahme unter Atmosphärendruck und Wasseraufnahme im Vakuum.[10]

Die Rohdichte [g/cm³] ist die Dichte eines Gesteins, einschließlich des Porenraums, im trockenen Zustand. Nach Prüfvorschrift DIN-EN 1936 wird ein volumenmäßig definierter Gesteinsprüfkörper nach der Trocknung bei 70°C gewogen, oder der Auftrieb, der mit Wasser gesättigten Gesteinsprobe bestimmt.

Die Reindichte [g/cm³] dagegen ist die Dichte der eigentlichen Gesteinssubstanz, also die Masse des porenfreien Volumenteils. Auch hier erfolgt die Bestimmung nach Prüfvorschrift DIN-EN 1936. Ebenfalls nach dieser Norm wird die Gesamtporosität [Vol.%] ermittelt. Diese ist der prozentuale Anteil des Gesamtporenvolumens am Gesamtvolumen des Gesteins. Die offene Porosität wird ebenfalls in [Vol.%] angegeben, umfasst aber nur den Porenraum, in dem Gase und Flüssigkeiten ausgetauscht werden können.

*Hygrische Dilatation*

Quellung unter Wasseraufnahme – als Quellung wird der Vorgang der Volumenänderung eines Festkörpers bei der Einwirkung von Flüssigkeiten und Gasen bezeichnet. Die mineralogische Zusammensetzung eines Gesteins verändert sich bei diesem Vorgang nicht, in vielen Fällen ist die aus der Zuführung des Wassers resultierende Volumenzunahme beim Trocknen vollständig reversibel. In diesem Zusammenhang hat insbesondere der Tonmineralgehalt eines Gesteins Einfluss, da Tonmineralien aufgrund ihres spezifischen Phänomens der interkristallinen Quellung eine zusätzliche Volumenzunahme des Gesteins bewirken.[11]

Die Quantifizierung des Quellens kann über die Messung der Längenänderung der Probe erfolgen. Als Fluid dient bei diesem Verfahren destilliertes Wasser. Die hygrische Längenänderung nähert sich als Funktion der Zeit aufgetragen asymptotisch einem Maximalwert an. Daher ist die Definition des Versuchsendes, also die Bestimmung des Zeitpunktes, an dem der Messwert abgelesen wird, erforderlich. Nur diese Übereinkunft liefert reproduzier- und vergleichbare Messwerte. Im Regelfall werden bei Sandsteinen 98 % der Längenänderung in den ersten 48 Stunden er-

Water absorption under atmospheric pressure is the highest possible water absorption of stone under normal pressure, determined using DIN-EN 13755 (formerly: DIN 52103). A sample, dried at 70°C and then cooled to room temperature, is immersed in distilled water for 48 hours before the amount of water absorbed is measured in relation to the weight of the dry sample [mass%]. Additionally, the amount of absorption in a vacuum is measured. The dry samples are evacuated and immersed in water for 48 hours before absorption is measured. The value of saturation is the ratio of water absorption under atmospheric pressure to water absorption in a vacuum.[10]

The bulk density [g/cm³] is the density of a stone including pore space when completely dry. In accordance with DIN-EN 1936 the buoyancy of the water-saturated specimen of defined volume is weighed after drying at 70°C.

The density [g/cm³] on the other hand is the density of only the stone substance itself, excluding the pores. DIN-EN 1936 is also used in this case to determine the total porosity [vol.%], which is the percent of total pore volume to the total volume of the stone. The actual porosity [vol.%] only includes the pore space in which gases and liquids can interact.

*Hygric Dilatation*

Swelling due to water absorption – swelling describes the process of solid matter that undergoes a change in volume due to exposure to liquids and gases. The mineral composition of stone does not change during this process. The water intake causes an increase in volume, which in most cases is reversible. The clay mineral content is significant due to the intercrystalline swelling of clay, which causes additional swelling in the stone.[11]

The quantification of swelling can be measured by evaluating the change of length of the sample using distilled water as fluid. The change of length due to hygric dilatation, in regard to time applied, asymptotically approaches a maximum value. Therefore it is necessary to define the end of the experiment, and thus at which point to take the final measurement. Only this method can provide comparable and reproducible values. In general, sandstones reach a 98 % change of length after the first 48 hours. Therefore, the 48-hour-value is used to calculate the hygric dilatation. In practice, the 48-hour-value is of significance because it is also used to calculate the water absorption and to determine the degree of swelling and shrinkage. Nevertheless, the specification of the interval and the period of measurement is important in order to adjust the results as seen in a greater context.[12]

reicht. Daher wird dieser Zeitpunkt als Versuchsende gewählt und der 48-Stunden-Wert als Endwert zur Berechnung der Feuchtedehnung herangezogen. In der Praxis kommt dem 48-Stunden-Wert eine große Bedeutung zu, da er ebenfalls zur Berechnung der Wasseraufnahme und zur Bestimmung des Quell- und Schwindmaßes dient. Trotzdem ist die Angabe der Messzeitintervalle und der Gesamtdauer des Versuchs wichtig, da so die Messergebnisse nachvollziehbar und in einen größeren Zusammenhang einzuordnen sind.[12]

*Sorptionsisotherme*

Anhand der Messreihen lässt sich beurteilen, wie die Wasseraufnahme des Gesteins im hygroskopischen Bereich (zwischen 0 und 98 % RH) bei unterschiedlichen Luftfeuchten verläuft.

Im Zusammenhang mit einer geplanten Gesteinsfestigung ist die Kenntnis der Sorptionsisotherme wichtig, um die für eine Tränkung geeigneten Luftfeuchtebedingungen festzulegen.[13] Da für die Aushärtung des Festigungsmittels ein gewisser Wassergehalt im Porenraum eines Gesteins erforderlich ist, ist anhand der Sorptionsisotherme festzulegen, in welcher Feuchtespanne das Gestein den erforderlichen Wassergehalt aufweist.

## Thermische Kennwerte

*Thermische Dilatation*

Die meisten Stoffe reagieren auf Erhitzung mit Volumenzunahme (Dehnung) und auf Abkühlung mit Volumenabnahme (Kontraktion). In der Praxis spielt die thermische Längenänderung dann eine Rolle, wenn das Gestein immer wieder natürlichen Temperaturschwankungen ausgesetzt ist, die zu Spannungen und Schäden im Materialgefüge führen.[14]

Die temperaturbedingte Längenänderung Δl eines Prüfkörpers ist bei nicht zu hohen Temperaturen und nicht zu großen Temperaturdifferenzen in erster Näherung proportional zur Temperaturänderung ΔT. Es gilt:

$$l_T = l_0 \cdot (1 + \alpha \cdot T)$$

ΔT = Temperaturdifferenz
$l_T$ = Länge bei der Temperatur T

Die Bestimmung des thermischen Ausdehnungskoeffizienten α [mm/m/°C] erfolgt nach Prüfvorschrift DIN-EN 14581. Es handelt sich um die lineare Ausdehnung eines Prüfkörpers bezogen auf seine Länge bei 20°C pro Grad Temperaturerhöhung. In der Laborpraxis wird der Prüfkörper auf eine definierte Temperatur erwärmt und seine Kontraktion während der Abkühlung ermittelt.[15]

*Isothermal Line of Sorption*

The isothermal line of sorption is used to determine why moisture has penetrated a stone. The series of measurements allow assessment of the rock's water absorption in the hygric range (between 0 and 98 % RH) at various constant and defined humidities.

While planning consolidation treatment, knowing the isothermal line of sorption is important in order to define ideal humidity conditions for use during treatment.[13] As a certain amount of water in the pore spaces is necessary for the consolidants to harden, the isothermal line of sorption allows to determine which relative humidity will ensure the necessary water content in the rock.

## Thermal Values

*Thermal Dilatation*

Most substances react to heat with an increase of volume (expansion) and to cooling with a loss of volume (contraction). In practice, thermal dilatation is important if a stone is exposed to repeated natural temperature variations, which causes stress and damage to the material structure.[14]

The thermal dilatation Δl of a stone is, at moderate temperatures and minor temperature changes, nearly proportional to the original length lo and the temperature difference ΔT.
The formula is:

$$l_T = l_0 \cdot (1 + \alpha \cdot T)$$

ΔT = temperature difference
$l_T$ = length at temperature T

The evaluation of the thermal dilatation coefficient α [µm/m/°C] is based on DIN-EN 14581. It is the linear dilatation of a specimen related to its length at 20°C per degree temperature increase. In practical laboratory work it is measured by heating the specimen to a defined temperature and measuring the contraction while cooling the sample.[15]

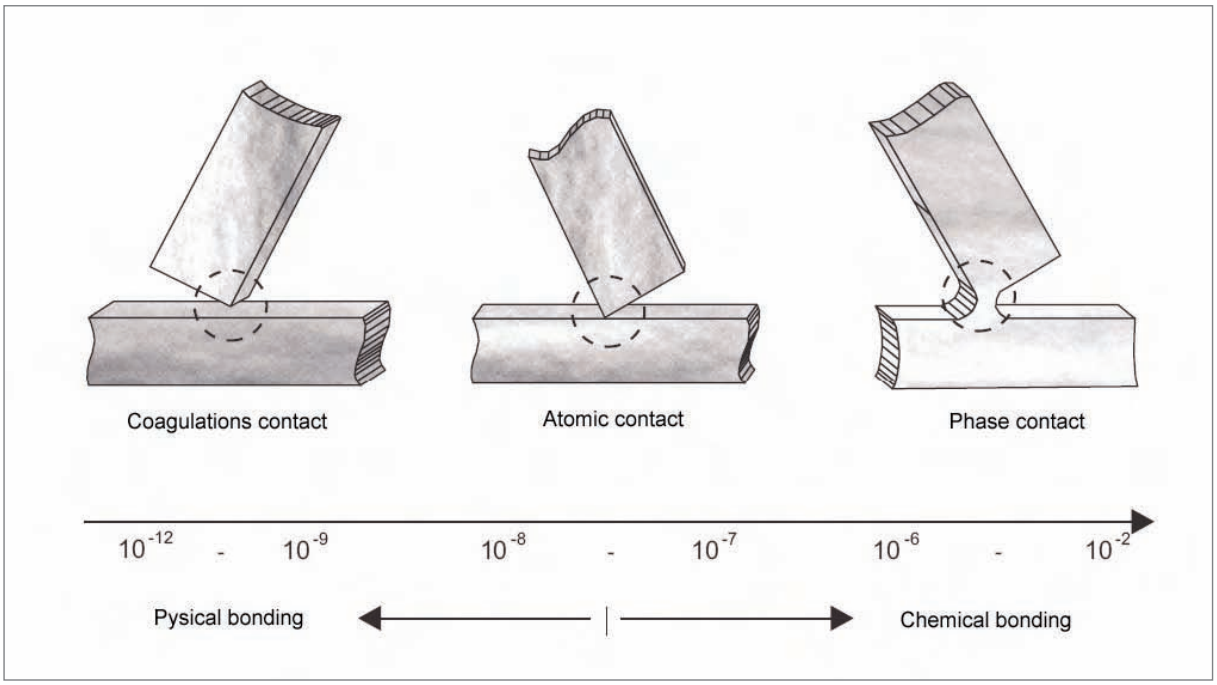



**Abb. 5:** Verschiedene Kontaktarten mit deren Bindungskräften / ***Fig. 5:*** *Various contact types with their corresponding bonding strength*

## Mechanische Kennwerte

Die mechanischen Eigenschaften eines Gesteins lassen sich durch die Messungen der Festigkeit und der Härte beschreiben. Zu beachten ist der Unterschied zwischen Festigkeit als mechanischer Widerstand, den ein Gestein seiner Verformung entgegensetzt, und Härte, als Widerstand des Gesteins gegenüber einer Verletzung seiner Oberfläche.[16]

Die Festigkeit kann durch die künstliche Verformung einer Gesteinsprobe mittels Druck/Zug bestimmt werden, wobei in der Regel der Druck angegeben wird, bei dem der Bruch eintritt. Ein Bruch ist dabei ein physikalisch komplexer Vorgang an dem Trenn-, Gleit-, Scher- und Verschiebungsbrüche beteiligt sind. Eingeleitet wird der Bruchbeginn durch Mikrorisse zwischen den Mineralkörnern.[17]

### *Biegezugfestigkeit*

Jede Form der Verwitterung bedeutet einen Verlust an Festigkeit. Dementsprechend sind die Messungen der Gesteinsfestigkeit vor allem hinsichtlich später folgender Konservierungsmaßnahmen von besonderem Interesse. Festigkeit lässt sich auch als Summe aller Bindungskräfte eines Stoffes definieren.[17] In den meisten Fällen existieren jedoch keine reinen Bindungsformen, sondern ein Nebeneinander der Bindungsarten Koagulationskontakt, atomarer Kontakt und Phasenkontakt (Abb. 5). Die Festigkeit wird von einer Vielzahl von Faktoren, wie Art des Materials, Form und Größe der Prüfkörper, Alterung, sowie Lagerung der Prüfkörper und Belastungsgeschwindigkeit beeinflusst. Aus diesem Grund ist Festigkeit keine

## Mechanical Values

The mechanical characteristics of stone can be described by determining its strength and hardness. The difference between strength as mechanical resistance with which a stone resists its deformation, and hardness as resistance of a stone towards the distortion of its surface must be taken into account.[17]

The strength can be determined by the deformation of a stone specimen placed under pressure or traction, while the pressure at which the fracture occurred is quoted. In physics, a fracture is a complex process involving breaks due to separation, sliding, shearing and shifting. The break begins with micro-fissures between the mineral grains.[18]

### *Biaxial Flexural Strength*

Every form of weathering causes loss in strength. Measuring the strength of stone is therefore of great significance especially when planning conservation treatments. Strength can be defined as the sum of bonding energy of a compound.[18] In most cases, there is no pure form of linkage but a coexistence of bonding types (coagulation contact, atomic contact and phase contact) (fig. 5). The strength is influenced by a number of parameters like material composition, form and size of the specimen, alteration and treatment of the samples. Strength is therefore not a value that can be definitely defined physically, and thus testing standards are necessary to guarantee comparability of the results.[19]

physikalisch eindeutig definierbare Größe, sondern von Übereinkünften abhängig, weshalb entsprechende Prüfungsnormen dazu dienen die Vergleichbarkeit der Ergebnisse zu gewährleisten.[19]

Nach Prüfvorschrift DIN-EN 14580 wird die Messung der Biegezugfestigkeit an Bohrkernscheiben mit Ringauflage durchgeführt. Der Scheibendurchmesser sollte mindestens 50 mm betragen, bei einem Verhältnis Scheibendurchmesser zu Scheibendicke von 1:10.

Die Korrelation von Spannung (Druckkraft/Fläche) und Dehnung (Längenänderung im Verhältnis zur ursprünglichen Länge) bei der Prüfung eines Natursteinprüfkörpers, ergibt im elastischen Bereich der Gesteinsbeanspruchung einen linearen Verlauf (Hooke'scher Bereich). Mit zunehmender Spannung weicht die Kennlinie von diesem linearen Verlauf ab, bis es zum Bruchversagen des Prüfkörpers kommt. Als Maß der Elastizität eines Stoffes gilt der Elastizitätsmodul (E-Modul), der im Bereich des linearen Verlaufs aus dem Anstieg der Spannungs-Dehnungs-Linie (Gerade) ermittelt wird (Proportionalitätsfaktor zwischen Spannung und Dehnung) E = Spannung/Dehnung. Dabei bedeutet ein niedriger Wert des E-Moduls eine starke Dehnung bei geringer Spannungsdifferenz, ein hoher Wert geringe Dehnung bei hoher Spannungsdifferenz.[20]

*Bohrhärte*

Die Bohrhärte ist auch ein Kennwert, der die Festigkeit eines Gesteins beschreibt, wobei hier ebenfalls Aussagen zum Tiefenprofil möglich sind. Die Grundlage hierbei ist die Korrelation zwischen Bohrwiderstand bzw. Bohrhärte und Festigkeit des Gesteinsmaterials. Das Prinzip dieser Messung beruht auf der Charakterisierung des Bohrvorgangs durch die Kenngrößen Drehzahl, Drehmoment und Anpressdruck. Wird jeweils eine Vorschub- und eine Drehkenngröße konstant gehalten, können die beiden anderen zur Bestimmung der Bohrhärte genutzt werden.

Das Bohrhärteprofil liefert Werte als [mm/min] oder Steigwinkel [°] der aufgezeichneten Kurve (Vorschubgeschwindigkeit) oder bei dem DRMS-Gerät der Firma Sint (Abb. 6, S. 134), welches im Zuge der Laboruntersuchungen am Bayerischen Landesamt für Denkmalpflege verwendet wurde, auch den Bohrwiderstand [N]. Die Bohrlöcher sind mit 2 bis ca. 10 mm vergleichsweise klein. Die Tiefenauflösung beträgt 1 mm, womit auch oberflächliche Entfestigungen oder Schalenbildung detektierbar sind. Verwendung finden Diamantbohrer, welche durch die Bohrung in ein Standardmaterial kalibriert werden. Jeder eingesetzte Bohrer muss katalogisiert werden, um für spätere Vergleichsmessungen wieder zur Verfügung zu stehen.[21]

According to the standard DIN-EN 14580 the measurement of bending biaxial flexural strength has to be performed with slices of stone placed between two steel rings. The stone slice diameter should be a minimum of 50 mm, with the ratio of slice diameter to slice thickness being 10:1.

The amount by which a material body is deformed (the strain) is linearly related to the force causing the deformation (the stress) (Hooke's law). With increasing inelastic deformation, the curve's course deviates from that linear curve until the specimens reaches its breaking point. The elasticity of a material is described by Young' s modulus (E-modulus), which is determined by the increase of the stress-strain-relation (straight line). A low E-modulus value indicates great strain with low tension differences, and a high E-modulus value indicates low strain with high tension differences.[20]

*Drilling Resistance*

The drilling resistance measurement is a micro-destructive method, which is used to determine the stone's hardness, whereby obtaining information about the depth profile is also possible. The basic principle here is the correlation between drilling resistance and strength of the stone material. The method is based on the characterization of the drilling process by using the values of drill speed, torque and contact pressure. If both the penetration and rotation values are kept constant, both other values can be used to determine the drill resistance.

The drilling resistance profile gives values as [mm/min] or ascent angle [°] of the recorded curve (penetration speed) or, for the DRMS machine from the company Sint (Fig. 6, p. 134), which was used for the analysis at the "Bayerisches Landesamt für Denkmalpflege", also the drilling resistance [N]. The drill hole with a diameter of two to ten millimetres is relatively small. A depth resolution of one millimetre allows detection of surficial alterations or contour scaling. The drill bits are diamond drill bits, which must be calibrated using a standard material. Every drill bit used must be named and stored for later use to obtain comparable measurements.[21]

**Abb. 6:** DRMS-Gerät der Fa. Sint mit Einspannvorrichtung zur Bohrhärtemessung von Materialproben / ***Fig. 6:*** *DRMS machine from the company Sint*

## Festigungsmaßnahmen

Die durch Verwitterungsprozesse bedingte Reduzierung der Bindungskräfte in einem Gestein führt zu dessen Festigkeitsverlust. Die Notwendigkeit einer Festigungsmaßnahme leitet sich vom Zustand des verwitterten Gesteins, sowie den Parametern des unverwitterten Gesteins ab. Durch eine Festigungsmaßnahme soll im verwitterten Gesteinsgefüge durch das Einbringen von Festigungsmitteln ein homogenes Festigkeitsprofil wiederhergestellt werden, welches dem Gefüge des unverwitterten Gesteins entspricht. Der erste Schritt besteht demnach in der Ermittlung der Kenndaten des intakten Gesteins. Danach wird das verwitterte Gestein mit unterschiedlichen, für die Festigung in Frage kommenden Festigungsmitteln behandelt. Abschließend werden sämtliche Kenndaten erneut an den behandelten Proben bestimmt, mit den Werten des unverwitterten Gesteins verglichen und das für die Festigung oder Hydrophobierung im Einzelfall geeignete Behandlungsmittel ausgewählt.[22]

### Steinfestigungsmittel

Im Rahmen dieser Laboruntersuchung wurde eine Vorauswahl von drei Steinfestigungsmitteln der Firma Remmers Baustofftechnik getestet: Funcosil Steinfes-

## Consolidation Treatment

The loss of bonding force caused by different weathering processes in the stone leads to loss of strength. The need for conservation treatment can be determined by analysing the state of the weathering as well as the parameters of an unweathered stone. The goal of consolidation treatment is to restore the weathered stone's homogenous depth profile, so that it is comparable to the unweathered stone, by use of a binder. The first step is therefore the determination of the values of the intact stone. Then, all values of the treated samples are again measured and again compared to the values of the intact stone. Finally, the product most suitable for consolidation treatment is chosen and tested.[22]

### Consolidation Products

For these laboratory tests, pre-selected consolidation products from the company Remmers were tested: Funcosil stone consolidant OH (KSE OH), Funcosil stone consolidant 100 (KSE 100) and Funcosil stone consolidant 300 (KSE 300).[23] These three stone consolidants are, according to the manufacturer's description, suitable for the consolidation of semi-porous, absorbent, unconsolidated mineral materials, especially sand-

**Tabelle 2:** Produktkenndaten der drei Festigungsmittel im Anlieferungszustand / ***Table 2:*** *Product specification of the three consolidants as indicated by the manufacturer*

| | **KSE OH** | **KSE 100** | **KSE 300** |
|---|---|---|---|
| Active ingredients [Mass%] | 75 | 20 | 99 |
| Catalytic system | neutral | neutral | neutral |
| Density at 20°C [g/cm$^2$] | 0,95 | 0,79 | 1,0 |
| Colour | clear, yellow touch | clear, yellow touch | clear, yellow touch |
| Smell | typical | typical | typical |

**Tabelle 3:** Produktkenndaten der drei Festigungsmittel nach der Applikation / ***Table 3:*** *Product specification of the three consolidants after application*

| | **KSE OH** | **KSE 100** | **KSE 300** |
|---|---|---|---|
| gel deposit [g/L] | 300 | 100 | 300 |
| reaction-related by-product | ethanol (gaseous) | ethanol (gaseous) | ethanol (gaseous) |

tiger OH (KSE OH), Funcosil Steinfestiger 100 (KSE 100) und Funcosil Steinfestiger 300 (KSE 300).[23] Diese drei Steinfestigungsmittel sind laut Herstellerangaben geeignet zur Festigung mittelporöser, saugfähiger, entfestigter mineralischer Baustoffe, insbesondere Sandstein.[24] Sie unterscheiden sich, wie Tabelle 2 und Tabelle 3 zeigen, hinsichtlich Wirkstoffgehalt, Dichte und abgeschiedener Gelmenge.

Die hier verwendeten Kieselsäureester (KSE) sind Ester der Orthokieselsäure $H_4SiO_4$. Diese Verbindungen entstehen durch Reaktion von Siliziumhalogeniden mit Alkoholen; sie werden auch als Ethylsilikate bezeichnet. Aufgrund ihrer Eigenschaft bei der Hydrolyse (z. B. durch Luftfeuchtigkeit) unter Abspaltung von Ethanol Siliziumdioxid zu bilden, finden sie als künstliche Bindemittel bei der Festigung von Naturstein Anwendung. Heute werden überwiegend Orthokieselsäuretetraethylester eingesetzt, deren festigende Wirkung auf der Ausbildung überbrückender, wasserhaltiger, amorpher $SiO_2$-Gele im Porenraum der Gesteine beruht.

stone.[24] They differ in regard to their active ingredients, density and gel deposit, as shown in tables 2 and 3.

The silicic esters (KSE) used here are orthosilicic acid $H_4SiO_4$ esters. These compounds result from the chemical reaction of silicon halogenides with alcohols; they are also called ethyl silicates. Due to their ability to produce silicon dioxide through hydrolysis (e.g. humidity) by releasing ethanol, they are used as artificial binders for the consolidation of natural stone. Today's Tetraethyl-orthosilic esters are predominantly used; their ability to consolidate comes from their formation of amorphous, hydrous $SiO_2$-gels that fills the pore spaces of the stones.

Der chemische und physikalische Erhärtungsprozess von KSE ist ein Sol-Gel-Prozess der in mehrere Phasen untergliedert werden kann:[25]

1. Verdunsten des Lösemittels ohne merkliche Steigerung der Viskosität der Lösung mit nur untergeordneter Hydrolyse. Es liegen lediglich isolierte Si-O-Si-Cluster vor.

2. Unmittelbar nach dem Verdunsten des Lösemittels findet ein gelartiges Ansteifen mit Viskositätszunahme statt.

3. Innerhalb der gelartig angesteiften Substanz kommt es laufend zu weiteren Hydrolyse- und nachfolgenden Kondensations- und Polymerisations-Prozessen, wobei Alkohol gebildet wird, der ständig verdunstet. Das Gel nimmt dabei an Dichte und Steifigkeit zu. Kondensationsreaktionen führen zu inneren Spannungen in den steifer werdenden Gelschichten, die so hoch werden, dass sie die innere Festigkeit überschreiten. Es bilden sich Schrumpfrisse.

4. Endpunkt der Gelbildung ist eine spröde, glasartige Substanz, deren allgemeine Formel als $SiO_2$ x $nH_2O$ angegeben wird.

Die gesamte chemische Reaktion lässt sich durch folgende Summenformel ausdrücken:

$$Si(OC_2H_5)_4 + 4H_2O \Rightarrow SiO_2 \cdot nH_2O + 4C_2H_5OH$$

Schematisch kann diese in zwei aufeinanderfolgende Teilschritte gegliedert werden:

1. Die Hydrolyse genannte Abspaltung der Alkylgruppen und eine Protonierung des freien Sauerstoffs zu Silanolgruppen.

2. Eine Kondensation und Polymerisation der SiOH-HOSi-Strukturen zu ungeordneten $SiO_2$-Tetraeder-Netzwerken unter $H_2O$-Abspaltung.

Diese Reaktionen ist sehr empfindlich bezüglich pH-Wert und Temperatur, welche die Geleigenschaften und die Gelierungszeit ebenso stark beeinflussen können wie die Anwesenheit von Salzen im Gestein.[26]

*Behandlung*

Im Labor wurden sechs Würfel (50 x 50 x 50 mm) mit den ausgewählten Steinfestigungsmitteln (KSE OH, KSE 100 und KSE 300) behandelt. Die Behandlung wurde unter konstanten Laborbedingungen bei 50 % relativer Feuchte und 22°C durchgeführt. Vor der Gesteinsfestigung wurde das Trockengewicht der Proben bestimmt. Die Mittelaufnahme der Gesteinsproben erfolgte durch kapillares Tränken: hierzu

The chemically and physically induced hardening process of KSE is a sol-gel process which can be divided into several phases:[25]

1. Evaporation of the solvent without a noticeable increase of viscosity and minor hydrolysis. Only isolated Si-O-Si-clusters are present.

2. After the evaporation of the solvent, sudden gel-formation takes place simultaneous to an increase of viscosity.

3. Inside the gel, further hydrolysis, condensation and polymerization continues to occur, whereby alcohol is produced. The alcohol evaporates and the gel's density increases. Condensation reactions cause inner tension in the gel layers. This tension becomes so strong that it exceeds the inner strength, leading to fissures.

4. The end product of the gel formation is a brittle, hyaline substance whose general formula is $SiO_2$ x $nH_2O$.

The entire chemical reaction could be described with the following molecular formula:

$$Si(OC_2H_5)_4 + 4H_2O \Rightarrow SiO_2 \cdot nH_2O + 4C_2H_5OH$$

This molecular formula can be schematically divided into two successive stages:

1. The separation of alkyl groups, called hydrolysis, and the protonation of free oxygen to silanol groups.

2. The condensation and polymerization of SiOH-HOSi-structures ($H_2O$ separation) to disordered $SiO_2$ lattice structures.

These reactions are sensitive to pH-values and temperatures, which influence the gel characteristics in the same way as the presence of salts does in the stone.[26]

*Consolidation Treatment Samples*

During these laboratory experiments six cubes (50 x 50 x 50 mm) were treated with the chosen consolidation products (KSE OH, KSE 100 and KSE 300). During treatment the laboratory conditions were kept constant at 50 % relative humidity and 22°C. Before treating the samples with the consolidation products their dry weight was determined. The consolidation product was absorbed by means of capillary immersion: One cube was brought into contact with the treatment products for one minute on each side, and one cube was soaked in the consolidation product completely. The specimens were then weighed after being swabbed on all sides, but before being dried (hardening of the

**Tabelle 4:** Festigung der sechs Gesteinswürfel / ***Table 4:*** *Consolidation of the six cubes*

| consolidation product | sample | weight before consolidation [g] | weight after consolidation [g] | weight dry after consolidation [g] | total uptake [g] | volatile compounds [g] | solid matter content [g] |
|---|---|---|---|---|---|---|---|
| KSE 100 1 min/side | **W 7** | 336,867 | 337,449 | 337,205 | 0,582 | 0,244 | 0,338 |
| KSE 100 soaked | **W 8** | 321,069 | 321,914 | 321,847 | 0,845 | 0,067 | 0,778 |
| KSE OH 1 min/side | **W 10** | 321,574 | 322,310 | 321,922 | 0,736 | 0,388 | 0,348 |
| KSE OH soaked | **W 9** | 328,385 | 329,315 | 329,241 | 0,930 | 0,074 | 0,856 |
| KSE 300 1 min/side | **W 11** | 338,223 | 338,779 | 338,540 | 0,556 | 0,239 | 0,317 |
| KSE 300 soaked | **W 12** | 333,309 | 334,341 | 334,204 | 1,032 | 0,137 | 0,895 |

wurde je ein Würfel eine Minute pro Seite mit den Behandlungsmitteln in Kontakt gebracht und je ein Würfel mit dem Festigungsmittel voll durchtränkt. Nach anschließendem allseitigen Abtupfen erfolgte die Wägung der Proben, bevor sie bei 65 % relativer Feuchte und einer Temperatur von 22°C zum Aushärten des Festigungsmittels gelagert wurden. Nach einer Trocknungsphase von sechs Wochen wurden die gefestigten Gesteinsproben erneut gewogen. Auf diesen unterschiedlichen Gewichten basieren die in Abbildung 7 visualisierten Werte der Festigungsmittelaufnahme.

consolidation agent) at 65 % relative humidity and 22°C. After the drying period of about six weeks, the treated samples were again weighed. The values of absorption of consolidation products shown in figure 7 are based on these differing weights.

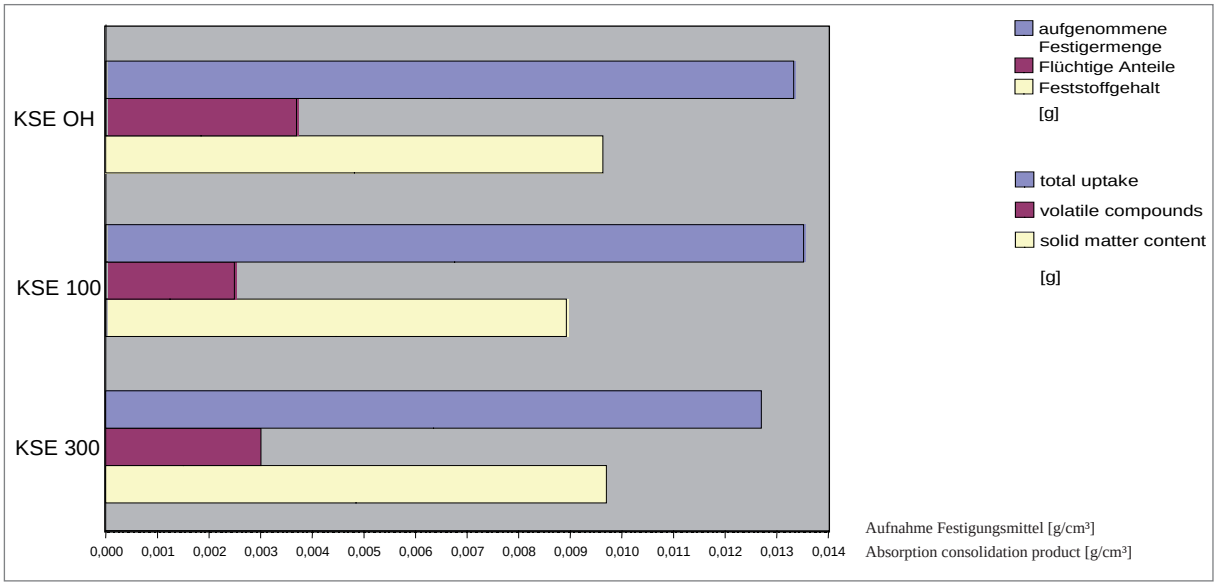



**Abb. 7:** Aufnahme der Festigungsmittel durch die Gesteinsproben der Jinchuanwan Grotte. Addierte Werte bei Tränkung und Behandlung des Würfels 1 Min./Seite / ***Fig. 7:*** *The Absorption of the consolidation products of the samples of the Jinchuanwan Grotto. Added values for the samples soaked in the consolidation product and had contact for one minute on each side*

*Parameter*

Zur Beurteilung und der endgültigen Auswahl eines geeigneten Festigungsmittels werden unterschiedliche Parameter herangezogen.[27]

Durch die Behandlung eines Gesteins mit Festigungsmitteln sollte das optische Erscheinungsbild des Materials nicht, oder nur geringfügig verändert werden. In der Praxis bewirken fast alle Gesteinsfestiger eine gewisse Dunklung, sodass das Kriterium „visuelle Eigenschaften“ immer für den Einzelfall subjektiv in situ bewertet werden muss.

Sowohl die Wasseraufnahme als auch das Eindringverhalten des Wassers sollten für ein Gestein nach der Festigungsmittelbehandlung geringfügig reduziert sein. Meist sinken beide Werte, da das Porengefüge durch das Behandlungsmittel verändert wird, wobei saugfähige Grobporen verengt werden.

Die Eindringtiefe des Festigungsmittels muss die Zone verminderter Festigkeit überbrücken und bis in die unverwitterte Zone reichen. In der praktischen Anwendung sollte die gewünschte bzw. erforderliche Eindringtiefe in einem zeitlichen Rahmen von zwei bis maximal fünf Minuten erreicht werden.

Die hygrische Dilatation, also die Quellung und Schrumpfung eines Gesteins unter dem Einfluss von Feuchte darf durch ein Festigungsmittel nicht so verändert werden, dass nach einer Behandlung verstärkt Spannungen im Gesteinsgefüge entstehen. Im optimalen Fall reduziert die Behandlung die Feuchtedehnung eines Gesteins.

Snethlage verweist auf die Bedeutung der Relation von Festigkeit zu E-Modul, welche in Folge einer Festigung nur in einem konstanten Verhältnis, welches dem Quotienten aus der Biegezugfestigkeit und dem E-Modul des unverwitterten Gesteins entspricht, zunehmen sollte.[28]

## Vorbemerkungen zu den Laboruntersuchungen

### Probenmaterial zur Untersuchung

Für die Untersuchungen wurden zwölf Gesteinswürfel und drei Bohrkerne nach Deutschland geschickt. Bei den Proben handelt es sich allerdings um unterschiedliches Gesteinsmaterial, was durch eine XRD-Analyse auch bestätigt wurde (siehe Auswertung Tabelle 5 und Diagramme auf Seite 163 im Anhang).

Die Bohrkerne weisen einen sehr hohen Calcitanteil auf und sind so dicht, dass eine Festigung dieses Gesteins nicht sinnvoll ist ($W_A$ = 0,22 Masse%, $W_V$ = 0,40 Masse%, Reindichte = 2,67 g/cm³, Rohdichte = 2,64 g/cm³). Daher wurden die Bohrkerne für die weiteren Untersuchungen ausgeschlossen, verwendet wurden nur die zwölf Gesteinswürfel 50 x 50 x 50 mm.

*Parameters*

There are various parameters for assessing the effectiveness of a consolidation product.[27]

In theory, the visual properties of the material should not change as a result of the consolidation treatment. In fact, most consolidation products cause a certain darkening of the stone. The criteria “visual characters” must therefore always be assessed separately for every single case. Water absorption and penetration should be reduced after the treatment. Both values usually drop due to reduction in the diameter of macro pores capable of absorbing.

The penetration depth of the consolidant must pass by the zone of reduced stability and reach the unweathered zone of the stone. In practice, the desired or necessary penetration depth must be reached in about two to maximum five minutes.

The hygric dilatation – the expansion and contraction of stone due to presence of moisture – must not be modified in a way that results in an increase in the inner tensions of the stone after treatment. In the best-case scenario, the treatment reduces the moisture expansion of a stone.

Snethlage refers to the importance of the relation of strength to the E-modulus, which should only increase in a constant proportion according to the quotient of bending tensile strength and the E-modulus of the unweathered stone.[28]

## Preliminary Remarks on Laboratory Analysis

### Ancillary Samples to be examined

Twelve stone cubes and three drilling cores were cut into slices and sent in for examination. The samples are all of a different stone material, which was confirmed by a XRD-analysis (evaluations in table 5 and diagrams on page 163 in the appendix).

The drilling cores showed a very high share of calcite, considering them being sandstone, and are too dense for a consolidation treatment. For this reason only the twelve stone cubes (50 x 50 x 50 mm) were used in the examination, and not the drilling cores.

*Processing of Samples*

Six of the cube samples were treated with consolidation products. The absorption of water and then the thermal and hygric dilatation were analysed on these samples. Stone slices were necessary for the evaluation of the bending tensile strength, moreover it is also easier to analyse the isothermal line of sorption with smaller samples. Drilling cores could be extracted from the cubes by water cooling and cut into sufficiently sized

*Bearbeitung der Proben*

Sechs der Probenwürfel wurden mit Steinfestigern behandelt. An diesen Proben wurden zuerst die Wasseraufnahme und anschließend die thermische und hygrische Dilatation bestimmt. Für die Messung der Biegezugfestigkeit werden Gesteinsscheiben benötigt, auch die Bestimmung der Sorptionsisotherme wird durch kleinere Proben erheblich vereinfacht. Es war möglich, aus den vorhandenen Würfeln mit Wasserkühlung Bohrkerne zu ziehen und von diesen Gesteinsscheiben ausreichender Größe (Durchmesser 45 mm, Dicke ca. 5 mm) zu schneiden. Die Bohrung erfolgte senkrecht zur Schichtung des Gesteins, die Scheiben wurden in Lagerrichtung geschnitten.

Die Beschriftung der Scheiben des Zylinders erfolgte von oben nach unten auf der Oberseite der Scheiben, die Nummerierung wurde an den Probenname angehängt (W 1-1, W 1-2 etc.).

*Verwendete Proben für die Messungen*

An den unbehandelten sechs Würfeln wurde die hygrische und thermische Dilatation gemessen und bei dreien die Wasseraufnahme. Für alle behandelten sechs Proben wurden dieselben Kennwerte bestimmt. Nach dem Schneiden der Scheiben wurden jeweils die drei obersten Scheiben zur Messung der Sorptionsisotherme verwendet. Die Bestimmung der Porosität erfolgte mittels Quecksilberporosimetrie an sechs Gesteinsstücken durch die Firma Quantachrome GmbH.

An dem untersten, dickeren Zylinderstück konnte die Bohrhärtemessung ausgeführt werden. Nach den Ergebnissen der Sorptionsisotherme wurde zusätzlich der Salzgehalt der unbehandelten Proben an Scheibe 1 bis 4 durch IC-Analyse untersucht. Abschließend wurde an allen Scheiben die Biegezugfestigkeit gemessen und der E-Modul bestimmt.

**Tabelle 5:** Halbquantitative Auswertung der XRD-Analyse / ***Table 5:*** *Evaluation of the semi-quantitativ XRD-analysis*

| **Cube W 7** | | **Drilling core B 1** | |
|---|---|---|---|
| Quartz | 54 % | Quartz | 31 % |
| Plagioclase | 30 % | Total feldspar | 30 % |
| Calcite | 7 % | Calcite | 36 % |
| Potash feldspar | 4 % | Chlorite | 2 % |
| Chlorite | 3 % | Plaster | 1 % |
| Glimmer | 2 % | | |

slices (diameter 45 mm, thickness approx. 5 mm). The stone was drilled perpendicularly to its layering; the slices were cut parallel to its layering. The slices of the cylinder were labelled top down and on their upper side; the numerations were appended to the sample names (W 1-1, W 1-2 etc.).

*Samples used for measurements*

The hygric and thermal dilatation were measured on all six unprocessed cubes, water absorption on three cubes. All six treated cubes showed the same characteristic values. After cutting the slices the upper three were used to measure the isothermal line of sorption. The company Quantachrome GmbH analysed the porosity of six unprocessed stone parts by mercury porosimetry.

The lowest, thicker cylinder slice was used for the measurement of its drill resistance. After obtaining the result of the isothermal line of sorption, the untreated samples' degree of salinity was examined additionally by an IC-analysis. Finally the bending tensile strength of the 5 mm thick slices was measured and their elastic modulus evaluated.

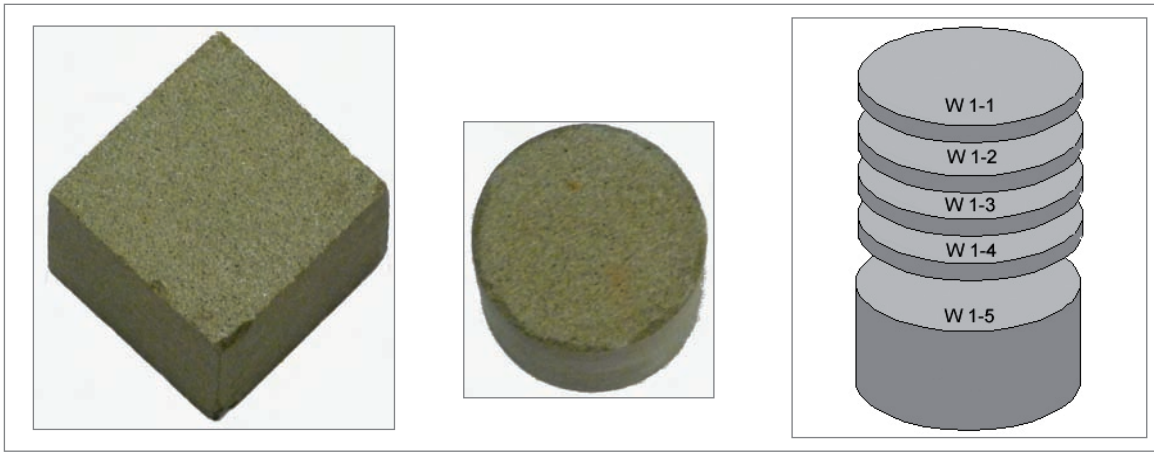



**Abb. 8:** Veränderung der Probengröße und schematische Darstellung der Beschriftung / ***Fig. 8:*** *Alteration to sample size and illustration of labelling*

## Gesteinskenndaten – Sandstein der Jinchuanwan Grotte

**Herkunft**
China, Provinz Shaanxi, Landkreis Chunhua, Jinchuanwan Grotte, die Grotte ist in eine gewachsene Felsformation eingearbeitet

**Geologisches Alter**
Unbekannt

**Petrografische Beschreibung**
*Gesamtfarbe*
Leicht grün-graue Färbung mit dunklen Biotit-Einschlüssen
*Struktur*
Feinsandig mit homogener Dichte
*Textur*
Nicht erkennbar

**Mikroskopische Beschreibung**
Feststoffanteil 99 %, sichtbarer Porenraum 1 % (Spaltporen entlang von Wachstumsgrenzen)

**Komponenten**
Quartz 40 %, Calcite 40 %, Alkalifeldspat 10 %, Biotite Glimmer 5 %, Gesteinsbruchstücke 5 %; Gesteinsbruchstücke: Mikroquarz und Schiefer, Alkalifeldspart mit teilweiser Kaolinitbildung

**Korngröße, Korngrößenverteilung und Kornform**
Korngrößen: 0,1–0,15 und 0,3–0,6 mm, gering sortiert
Kornform: angular – subangular
Sphärizität: I–II / 2–4
Kornkontakt: 70–100 % im Untersuchungsbereich

**Diagenese**
Calcitische Formation

**Klassifikation**
Carbonatischer Sandstein mit geringem Feldspatanteil

## Stone Features – Sandstone from the Jinchuanwan Grotto

**Origin**
China, Province Shanxi, District Chunhua, Jinchuanwan Grotto, the grotto is part of a rock formation

**Geological Age**
Unknown

**Petrographic Description**
*Colour*
Slight green-grey colouring with dark biotite shades
*Structure*
Fine sand with homogenous density
*Texture*
Not identified

**Microscopic description**
Proportion of solid material 99 %, visible pores 1 %, (only very little slit pores along grain boundaries)

**Components**
Quartz 40 %, Calcite 40 %, Potash feldspar 10 %, Biotite glimmer 5 %, rock fragments 5 %; Rock fragments: Microquartz and schists, potash feldspar, partly with kaolinite formation

**Grain Size, Grain Size Distribution and Grain Form**
Grain sizes: 0.1–0.15 and 0.3–0.6 mm
Grain form: angular – subangular
Sphericity: I–II / 2–4
Grain contact: 700–100 %

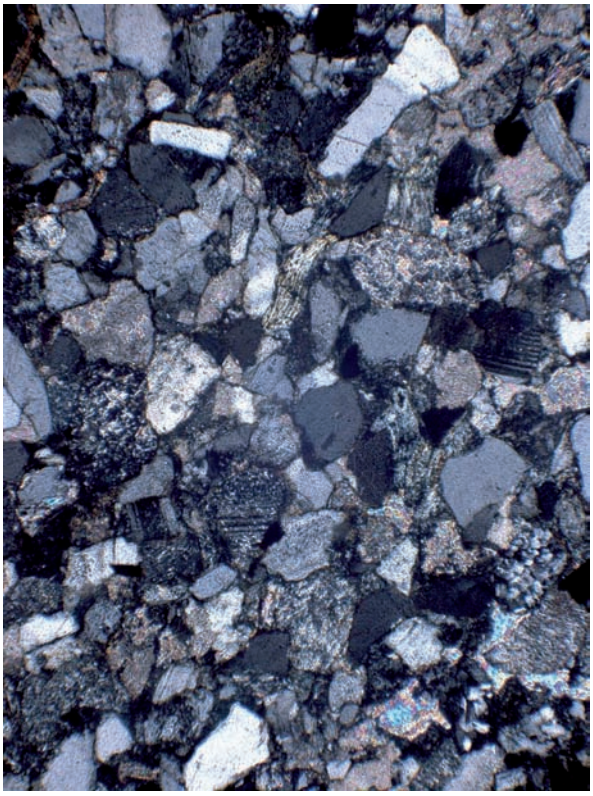
**Diagenesis**
Calcite formation

**Classification**
Carbon sandstone with low proportion of feldspar

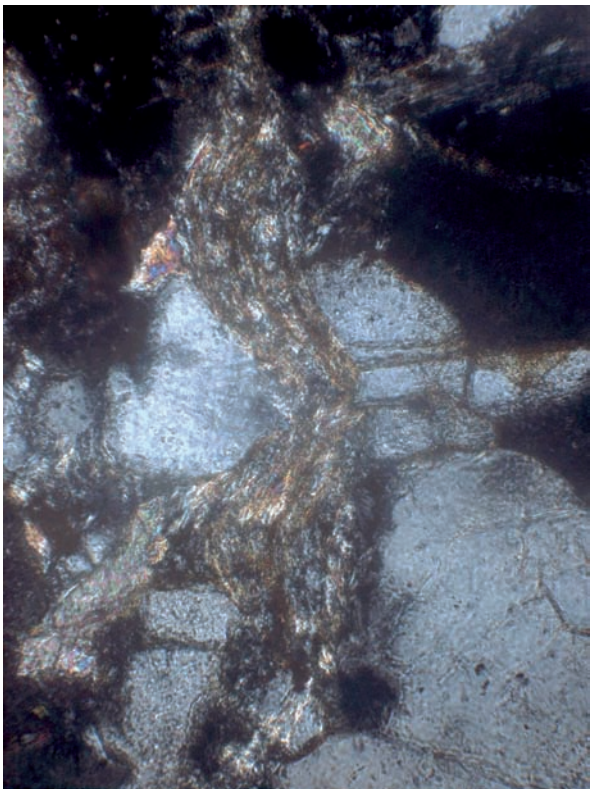
| | | | |
|---|---|---|---|
| Density | | [g/cm³] | 2.68 |
| Bulk Density | | [g/cm³] | 2.59 |
| Water absorption | (atmospheric pressure) | [mass%] | 1.20 |
| | (vacuum) | [mass%] | 1.31 |
| Porosity | | [vol.%] | 3.40 |
| Saturation | | [-] | 0.91 |
| Hygric Dilatation ($H_2O$) | (ll ss) | [µm/m] | 0.64 |
| | (⊥ ss) | [µm/m] | 0.85 |
| Thermic Dilatation | (ll ss) | [µm/°C] | 0.46 |
| | (⊥ ss) | [µm/°C] | 0.47 |
| E-modulus | | [kN/mm²] | 30 |
| Biaxial flexural strength | (⊥ ss) | [N] | 55 |

**Tabelle 6:** Gesteinskenndaten /
***Table 6:*** *Stone values*

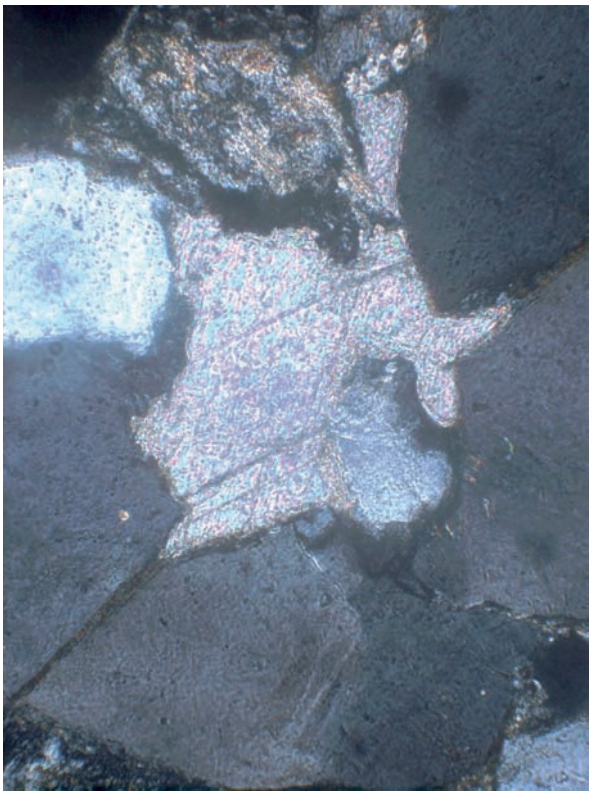
Untersuchter Dünnschliff / *Overview of Jinchuanwan Grotto sandstone thin section*



Mikroskopische Übersicht des untersuchten Dünnschliffs; 63-fache Vergrößerung mit Polarisatoren / *Microscopic overview of the thin section; PM Nicols +. Magnification 63 x*



Interstadiale von Quarzkörnern umgebene calcitische Füllung, 220-fache Vergrößerung mit Polarisatoren / *Interstitial calcite filling surrounded by quartz grains. Thin section. PM Nicols +. Magnification 220 x*



Gekrümmte Glimmerkristalle umgeben von Quarzkörnern, 200-fache Vergrößerung mit Polarisatoren / *Bended mica crystal surrounded by quartz grains. Thin section. PM Nicols +. Magnification 200 x*

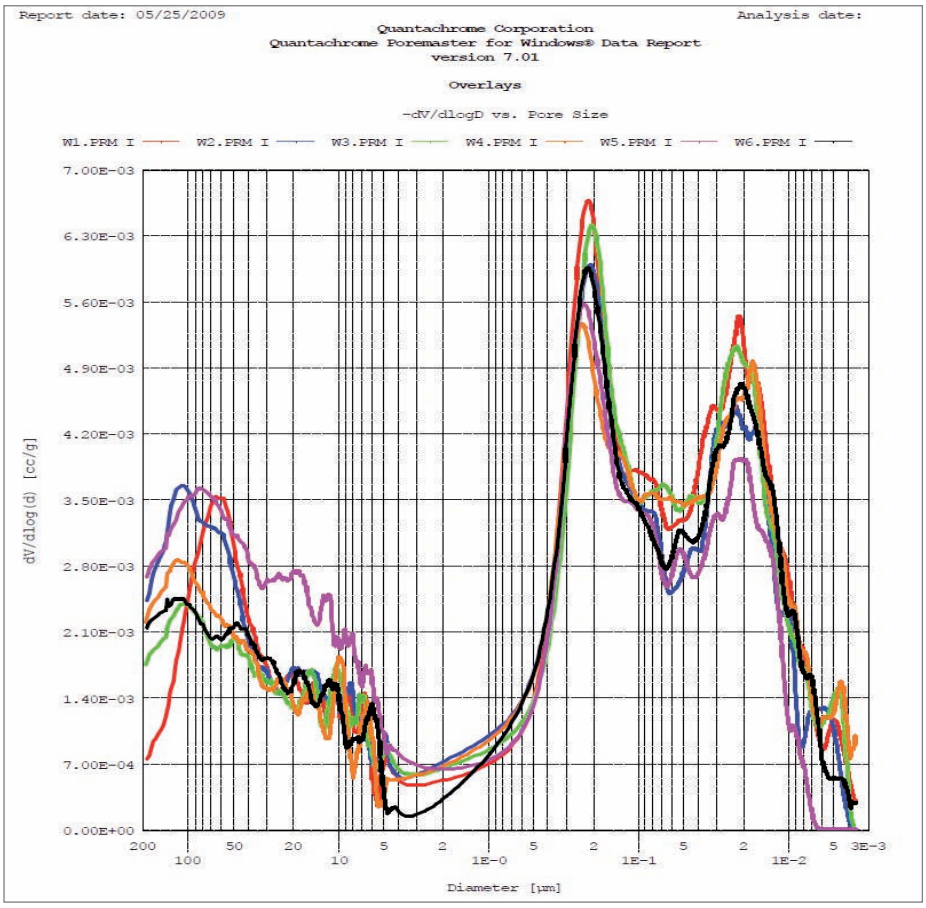



**Abb. 9:** Ergebnis der Quecksilberporosimetrie / ***Fig. 9:*** *Results of the Mercury Porosimetry*

## Ergebnisse der unbehandelten Proben

### Feuchtekennwerte

*Porosität – Quecksilberporosimetrie*

Die Bestimmung der Porosität erfolgte mittels Quecksilberporosimetrie an sechs unbehandelten Gesteinsproben durch Dipl.-Ing. Helmut Gronegger der Quantachrome GmbH in Odelzhausen an einem Quantachrome Poremaster 60-GT.

Da die Proben augenscheinlich keine Poren im Größenbereich größer 200 µm enthalten, wurde nicht der gesamte mögliche Messbereich des Gerätes genutzt, sondern die Messungen bei 200 µm gestartet. Der Einfluss des „Zwischen-Korn-Volumen“ wird dadurch etwas minimiert.

Die Kurve (Abb. 9) stellt den Anteil der entsprechenden Porenradien an der Gesamtporenzahl dar. Alle Proben zeigen ein sehr ähnliches Intrusionsverhalten: Ab der Messobergrenze (ca. 200 µm) zunächst eine Intrusionsstufe bis in den Bereich von etwa 4 µm, was durch Gronegger als das Füllen von Zwischen-Korn-Volumen interpretiert wird. Die eigentliche Porenfüllung findet erst unterhalb dieser Marke statt. Das erste Maximum liegt im Bereich 0,2–0,25 µm, das zweite

## Results of the Untreated Samples

### Hygric Values

*Porosity – Mercury Porosimetry*

The porosity was determined using mercury porosimetry on six untreated samples by Dipl.-Ing. Helmut Gronegger from Quantachrome GmbH in Odelzhausen with a Quantachrome Poremaster 60-GT.

As the samples do not seem to have any pores larger than 200 µm, the measurements were started at 200 µm, instead of using the entire possible range of measurement of the device. With this, the influence of the “inter-grain-volume” was minimized slightly.

The curve (Fig. 9) indicates the ratio of the pore radii to the total number of pores. All samples show a similar manner of intrusion: From the starting point of the measurement (approx. 200 µm) there is first of all a degree of intrusion up into the range of about 4 µm, which is interpreted by Gronegger as the filling of volume in between grains. The actual pore filling does not start until below this mark. The first maximum is in the region of 0.2–0.25 µm, the second maximum at about 0.02 µm. The pores are micropores, classified according to the architectural method indicated

Maximum bei etwa 0,02 µm. Die Poren sind, nach der in Tabelle 1 (S. 129) dargestellten bauphysikalischen Klassifizierung der Porengrößen, Mikroporen zuzuordnen. Bei den untersuchten Gesteinsproben handelt es sich also um einen feinporigen Sandstein.

*Wasseraufnahme*

Zur Ermittlung der Wasseraufnahme an den Proben der Jinchuanwan Grotte wurden diese 48 Stunden in einem Trockenschrank bei 60°C bis zur Massenkonstanz gelagert. Vor der Bestimmung des Trockengewichts ($m_0$) wurden die Proben im Exsikkator auf Raumtemperatur abgekühlt.

Die Bestimmung der Wasseraufnahme erfolgte unter Atmosphärendruck ($W_A$) und im Vakuum ($W_V$). Bei der Wasseraufnahme unter Atmosphärendruck nimmt die Gesteinsprobe das Wasser kapillar auf. Hierzu wird die Probe etwa einen Zentimeter tief in Wasser getaucht, wobei das Wasser kapillar in das Gestein gesaugt wird, bis es auf der Oberseite des Prüfkörpers durchschlägt. Dann werden die Proben vollständig mit einer Wasserüberdeckung von etwa drei Zentimetern für 48 Stunden in Wasser gelagert, bevor ihr Nassgewicht ermittelt wird.

Zur Bestimmung der Wasseraufnahme im Vakuum werden die Gesteinsproben zunächst für mindestens fünf Stunden in einem Exsikkator evakuiert. Dieser wird anschließend mit Wasser geflutet, bis die Gesteinsproben etwa drei Zentimetern Wasserüberdeckung aufweisen. Wieder wird nach 48 Stunden Lagerung das Nassgewicht bestimmt und zusätzlich durch eine Wägung unter Wasser, der Auftrieb der Gesteinsproben (Volumenermittlung) durchgeführt.

Tabelle 7 zeigt die aus den Ergebnissen der Wasseraufnahme bestimmbaren Gesteinskennwerte, wie Porosität, Sättigung, Reindichte und Rohdichte. Die Untersuchungsprotokolle sind diesem Bericht im Anhang auf den Seiten 164 bis 165 beigefügt.

Die Porosität der untersuchten Proben mit durchschnittlich 3,4 Vol.% ist relativ niedrig. Die Wasseraufnahme des Sandsteins ist sehr gering unter Vakuum wird mit 1,31 Masse% nur wenig mehr Wasser aufgenommen als unter Atmosphärendruck mit 1,20 Masse%. Es handelt sich hierbei um einen sehr dichten Sandstein.

in table 1 (p. 129). The examined stone samples are therefore fine-pored sandstone.

*Water Absorption*

To assess the water absorption of the samples from the Jinchuanwan Grotto, they were placed in a cabinet drier with a temperature of 60°C for 48 hours to reach their constant mass. Before determining the dry weight ($m_0$) the samples were placed in an exsiccator until they reached room temperature.

Determination of water absorption took place under atmospheric pressure ($W_A$) in a vacuum ($W_V$). Rock under atmospheric pressure absorbs water through its capillaries. To this end, the samples are immersed in approximately one centimetre of water, and the rock absorbs the water through its capillaries until it reaches the surface of the sample. The samples are then totally immersed in ca. three centimetres of water for 48 hours before the wet weight is determined.

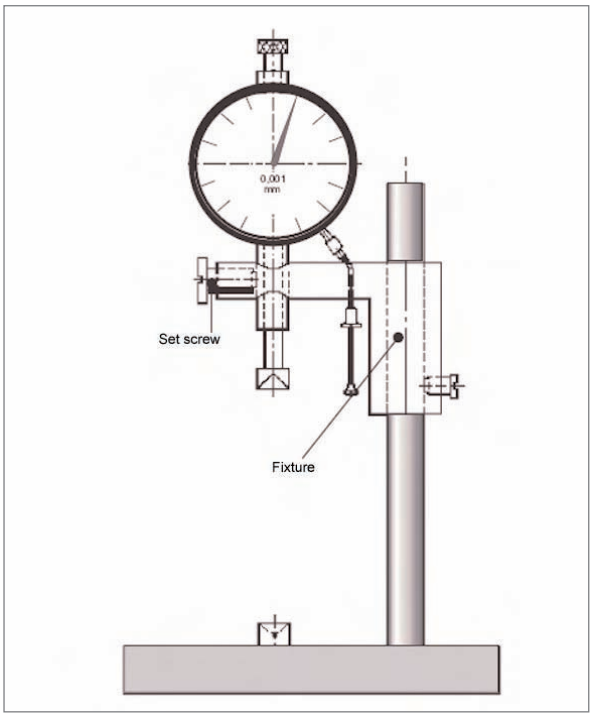
To assess water absorption in a vacuum, the samples are initially placed in an exsiccator for a minimum of five hours. The exsiccator is subsequently flooded with water until the samples are immersed in around five centimetres of water. Again, the wet weight is determined after 48 hours. Additionally, by weighing under water, the buoyancy (determination of volume) is tested.

Table 7 shows the resulting values gathered from water absorption, like porosity, saturation, particle density and bulk density. The complete results of the analyses can be found in the appendix, pages 164 to 165.

The porosity of the samples tested is relatively low (3.4 vol.%). The value of the sandstone's water absorption is very low. The value of water absorption when subject to vacuum pressure (1.31 mass%) is only slightly higher than the value of water absorption under atmospheric pressure (1.20 mass%). Therefore it is a very dense sandstone.

**Tabelle 7:** Ergebnisse der Ermittlung der Wasseraufnahme an den unbehandelten Würfeln / ***Table 7:*** *Results of water absorption tests on the untreated cube samples*

| **Sample** | **WA** [mass%] | **WV** [mass%] | **Porosity** [vol.%] | **Saturation** [–] | **Density** [g/cm³] | **Bulk Density** [g/cm³] |
|---|---|---|---|---|---|---|
| W 1 | 1.09 | 1.2 | 3.11 | 0.91 | 2.67 | 2.59 |
| W 2 | 1.16 | 1.3 | 3.36 | 0.89 | 2.68 | 2.59 |
| W 3 | 1.34 | 1.44 | 3.72 | 0.93 | 2.69 | 2.59 |
| **Average** | **1.20** | **1.31** | **3.40** | **0.91** | **2.68** | **2.59** |



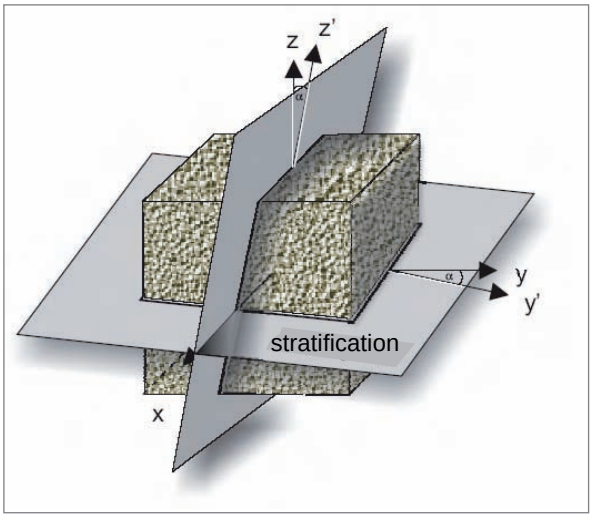




**Abb. 11 (oben):** Lage der Schichtungsebene / ***Fig. 11 (above):*** *Position of stratification*

**Abb. 10 (links):** Messuhr für hygrische und thermische Dilatation / ***Fig. 10 (left):*** *Dial gauge for determining hygric and thermic dilatation*

*Hygrische Dilatation*

Die hygrische Dilatation wurde für den Sandstein der Jinchuanwan Grotte unter Wasser jeweils in x-, y- und z-Richtung (Tab. 8) bestimmt. Hierfür wurde das Trockengewicht der Proben (Trockenschrank bei ca. 60°C und anschließendes Abkühlen im Exsikkator) ermittelt bevor sie in die Messuhren (Abb. 10) eingespannt wurden.

Die Messdauer der hygrischen Dilatation unter Wasser betrug 48 Stunden. Tabelle 8 zeigt die Mittelwerte der Ergebnisse der hygrischen Dilatation unter Wasser jeweils für die drei Raumrichtungen (Abb. 11). Die Untersuchungsprotokolle mit den detaillierten Werten sind diesem Bericht im Anhang auf den Seiten 166 bis 177 beigefügt.

Der Tabelle 8 ist zu entnehmen, dass das Gestein seine größte Ausdehnung in z-Richtung (⊥ ss) erreicht, wogegen die Werte der x- und y-Richtung (ll ss) geringer sind. Der Wert der x-Richtung (0,61) in Bezug zur y-Richtung (0,67) spiegelt die Qualität des Würfels in Bezug zur Schichtungsebene des Sandsteins wieder.

**Tabelle 8:** Mittelwerte der hygrischen Dilatation unter Wasser / ***Table 8:*** *Average values of hygric dilatation under water*

| Direction | Hygric Dilatation under Water [mm/m] |
|---|---|
| x (ll ss) | 0.61 |
| y (ll ss) | 0.67 |
| z (⊥ ss) | 0.85 |

*Hygric Dilatation*

The hygric dilatation of the Jinchuanwan sandstone was determined under water in directions x, y and z (Table 8). The dry weight of the samples (cabinet dryer at ca. 60°C and subsequent cooling in an exsiccator) was determined before they were mounted in the dial gauge (fig. 10).

The measurement period of the hygric dilatation under water was 48 hours. Table 8 shows the average values of hygric dilatation under water for all three directions (fig. 11). The complete results of the analyses can be found in the appendix on pages 166 to 177.

As indicated in table 8, the rock reached its greatest dilatation in direction z (⊥ ss), while the values of directions x and y (ll ss) are lower. The value of direction x (0.61) in relation to the value of direction y (0.67) shows the quality of the stone in relation to the stratification of the sandstone.

**Tabelle 9:** Relative Feuchte über den verwendeten gesättigten Salzlösungen /***Table 9:*** *Relative humidity with saline solutions*

| Salt | Relative Humidity at 20°C [%] | Solubility at 20°C [g/100g $H_2O$] |
|---|---|---|
| Calcium Chloride | 32 | 73.9 |
| Kalium Carbonate | 45 | 110.6 |
| Ammonium Nitrate | 63 | 189.6 |
| Sodium Chloride | 75 | 36.0 |
| Potassium Chloride | 86 | 34.4 |
| Copper Chloride | 98 | 11.1 |

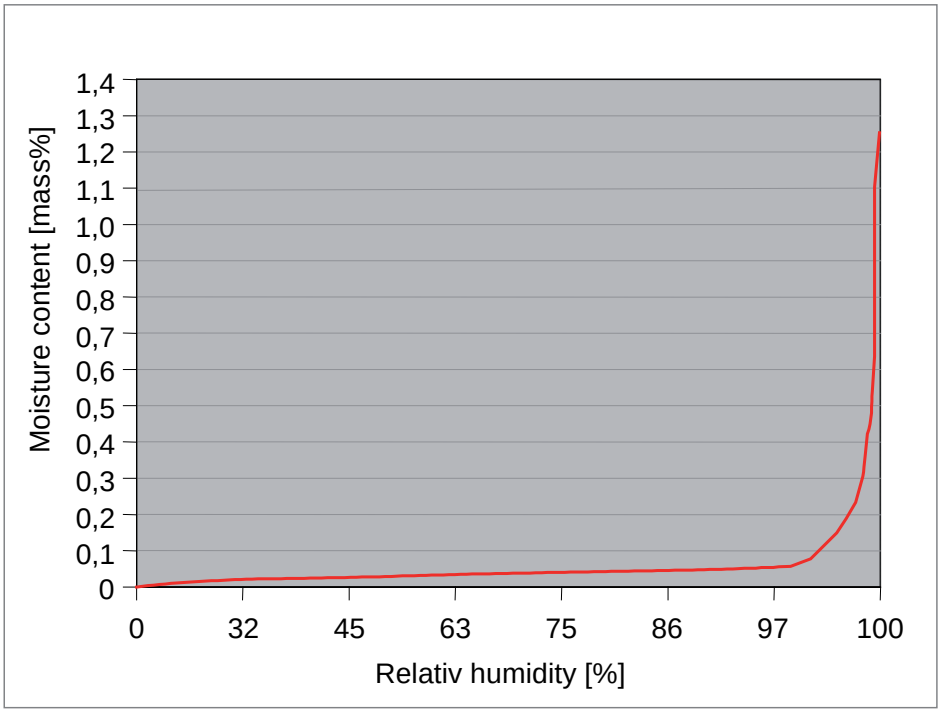



**Abb. 12:** Verlauf der Sorptionsisotherme, Kurve ermittelt anhand der Messergebnisse der unbehandelten Proben / ***Fig. 12:*** *Course of the isothermal line of sorption, determined using the measured values of the untreated samples*

*Sorptionsisotherme*

Die Sorptionsisotherme wurde bei folgenden relativen Luftfeuchten ermittelt: 32 % RH, 45 % RH, 63 % RH, 75 % RH, 86 % RH und 98 % RH. Hierfür wurden die jeweiligen Luftfeuchten mittels entsprechender Salze (Tab. 9) in Exsikkatoren erzeugt.

Die Messung der Sorptionsisotherme erfolgte für jede relative Feuchte an jeweils drei Scheiben der Proben. Bevor die Proben in den Exsikkatoren bis zur Gewichtskonstanz gelagert wurden, wurde nach einer Trocknung im Trockenschrank 48 Stunden bei 60°C und einer Abkühlung im Exsikkator ihr Trockengewicht bestimmt. Die Scheiben wurden jeweils bis zur Gewichtskonstanz (3 bis 7 Tage) in den Exsikkatoren gelagert. Nach dem Erreichen der Messwertkonstanz wurden die Proben gewogen und die aufgenommene Menge Wasser in Prozent ermittelt. Abbildung 12 zeigt eine Kurve ermittelt aus den Mittelwerten der unbehandelten Proben bei den entsprechenden Luftfeuchten. Den Endwert der Kurve bildet die Lagerung der Proben unter Wasser über 48 Stunden. Die Untersuchungsprotokolle sind diesem Bericht im Anhang auf den Seiten 190 bis 193 beigefügt.

In den Messwerten zeigten die Proben keine Auffälligkeit allerdings war das Feuchteverhalten der Scheiben optisch sehr unterschiedlich. Bei 97 % Luftfeuchte waren die Scheiben, die von der Oberfläche der Würfel geschnitten wurden noch trocken, zeigten nur punktuell kleine feuchte Stellen, die unteren beiden Scheiben waren nass, teilweise mit Tropfenbildung auf den Scheiben (Abb. 13). Diese Unterschiede sollten bei einem unbehandelten Gestein nicht auftreten. Es wurde daher zusätzlich der Salzgehalt der Proben anhand IC-Analyse bestimmt.

*Isothermal Line of Sorption*

The isothermal line of sorption was determined using the following relative humidity values: 32 % RH, 45 % RH, 63 % RH, 75 % RH, 86 % RH and 98 % RH. To this end, the respective humidity values were generated using saline solutions (table 9) in exsiccators.

Measurement of the isothermal line of sorption was taken for each relative humidity on three slice samples. Before the samples were placed in the exsiccators, their dry weight was determined after being dried in a cabinet drier at 60°C for 48 hours and cooled in an exsiccator. The samples were stored in exsiccators until they reached their constant weight (3 to 7 days). After reaching their constant values, the samples were weighed and the percent of water absorbed determined. Figure 12 shows a graph line based on the average values of the untreated samples for the respective humidity. The final value shows the storage of the samples under water for 48 hours. The complete results of the analyses can be found in the appendix on pages 190 to 193.

The samples did not show any conspicuousness in the measurement values. However, the reaction of the slices to humidity varied optically. At a humidity of 97 % the slices cut from the upper part of the cube were still dry and only had a few small damp parts, whereas both slices from the lower part of the cube were wet, partly with drop formations on the slices (Fig. 13). These differences should not occur on untreated stones. For this reason the salt content of the samples was additionally determined by means of an IC-analysis.

**Abb. 13:** Die unbehandelten Proben W1, W2 und W3 im Exsikkator bei 97 % relativer Luftfeuchte. Die Scheiben 1-1, 2-1 und 3-1 sind trocken, die Scheiben 1-2, 1-3, 2-2, 2-3, 3-2 und 3-3 sichtbar nass / ***Fig. 13:*** *The untreated samples W1, W2 and W3 in the exsiccator at 97 % relative humidity. The slices 1-1, 2-1 and 3-1 are dry; the slices 1-2, 1-3, 2-2, 2-3, 3-2 and 3-3 are visibly wet*

*IC-Analyse*

Die Analyse wurde an einer Gesteinscheibe aus der Mitte des Würfels durchgeführt. Da an allen Gesteinswürfeln zuvor die hygrische Dilatation gemessen wurde, ist die tatsächliche Salzbelastung des Gesteins sicherlich höher. Die Messung zeigt trotzdem eine deutliche Salzbelastung im Gestein. Das Ergebnis ist nach WTA-Merkblatt E 3-13-1/D (Tabelle 10) als mittel belastet (Stufe 2) einzustufen. Maßnahmen zur Entsalzung sind hier im Einzelfall erforderlich. Ursache für die Salzbelastung kann die Lage der Entnahmestelle der Gesteinsproben sein, dazu gibt es allerdings keine genauen Angaben.

*IC-Analysis*

A slice from the middle of the cube was analysed. As the hygric dilatation was measured on all stone cubes previously, the actual salinity of the stone is certainly higher. Nevertheless, the measurement shows a considerable salt content of the stone. The result is rated as having a medium salt load (stage 2) according to WTA Information sheet E 3-13-1/D (table 10). Measures for desalination are required in individual cases. The location of the sampling point of the stone could be responsible for the high salt content; however, there is no further information on this.

**Tabelle 10:** Einstufung der Salzbelastung nach WTA-Merkblatt E 3-13-1/D / ***Table 10:*** *Classification of salt content according to WTA Information sheet E 3-13-1/D*

| Assessment | Sulphate (g/kg) | Chloride (g/kg) | Nitrate (g/kg) |
|---|---|---|---|
| Stage 0 = minimal salt load | up to 0.2 | up to 0.1 | up to 0.2 |
| Stage 1 = low salt load | up to 1.0 | up to 0.3 | up to 0.5 |
| Stage 2 = medium salt load | up to 2.0 | up to 1.0 | up to 2.0 |
| Stage 3 = high salt load | up to 8.0 | up to 3.0 | up to 5.0 |
| Stage 4 = extremely high salt load | over 8.0 | over 3.0 | over 5.0 |

**Tabelle 11:** Thermische Dilatation / ***Table 11:*** *Thermal Dilatation*

| Direction | Linear Expansion Coefficient a [µm/m/°C] |
|---|---|
| x (ll ss) | 0.46 |
| y (ll ss) | 0.46 |
| z (⊥ ss) | 0.47 |

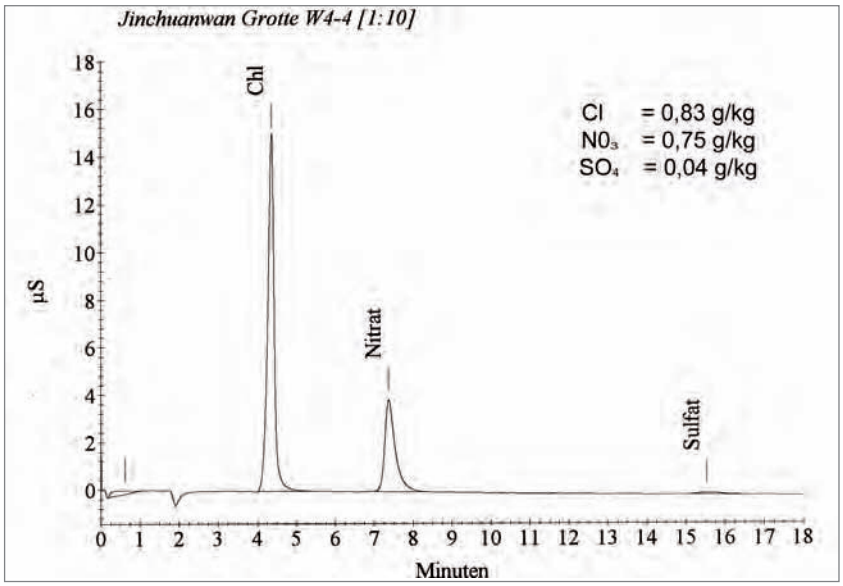



**Abb. 14:** Messkurve der IC-Analyse mit Auswertung des vorhandenen Salzgehalts in g/kg / ***Fig. 14:*** *Measurement graph of the IC-analysis with an evaluation of the salt content in g/kg*

## Thermische Kennwerte

### *Thermische Dilatation*

Die thermische Dilatation zeigt, wie sich das Gestein bei Temperaturschwankungen ausdehnt oder zusammenzieht. Die thermische Dilatation wird im Laborversuch ermittelt, indem die Gesteinsprobe auf etwa 60°C erhitzt, in eine Messuhr (Abb. 10, hygrische Dilatation) eingespannt und die bei der Abkühlung auftretende Längenänderung ermittelt wird. Auch die thermische Dilatation wurde in x-, y- und z-Richtung bestimmt (Abb. 15). Tabelle 11 liefert im Überblick die Mittelwerte der Untersuchungsergebnisse, die Versuchsprotokolle sind diesem Bericht im Anhang auf den Seiten 178 bis 189 beigefügt.

Wie die Tabelle 11 zeigt, ist die thermische Dilatation ist in allen drei Raumrichtungen identisch.

## Thermal Values

### *Thermal Dilatation*

Thermal dilatation indicates how rock either expands or shrinks depending upon temperature. Thermal dilatation is determined in a laboratory by heating the rock up to circa 60°C, mounting it in a dial gauge (fig. 10, hygric dilatation) and measuring the change in size as it cools. The thermal dilatation was also measured in directions x, y and z (fig. 15). Table 11 shows the average results, the complete results of the analyses can be found in the appendix on pages 178 to 189.

As shown in table 11, the thermal dilatation is identical in all three directions.

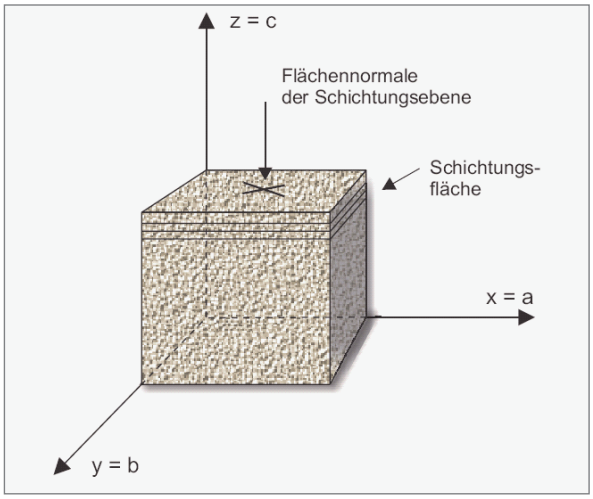



**Abb. 15:** Orientierung der Prüfkörper im Koordinatensystem / ***Fig. 15:*** *Orientation of test specimens in a coordinate system*

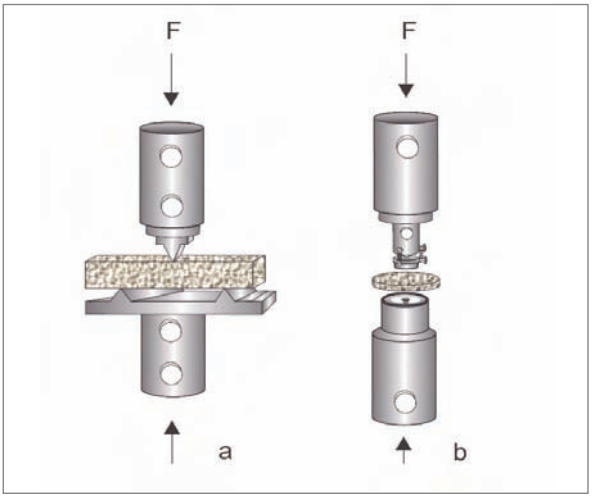



**Abb. 16:** Prüfanordnung zur Ermittlung der uniaxialen (a) und biaxialen (b) Biegefestigkeit /***Fig. 16:*** *Test set-up for determining uniaxial (a) and biaxial (b) flexural strength*

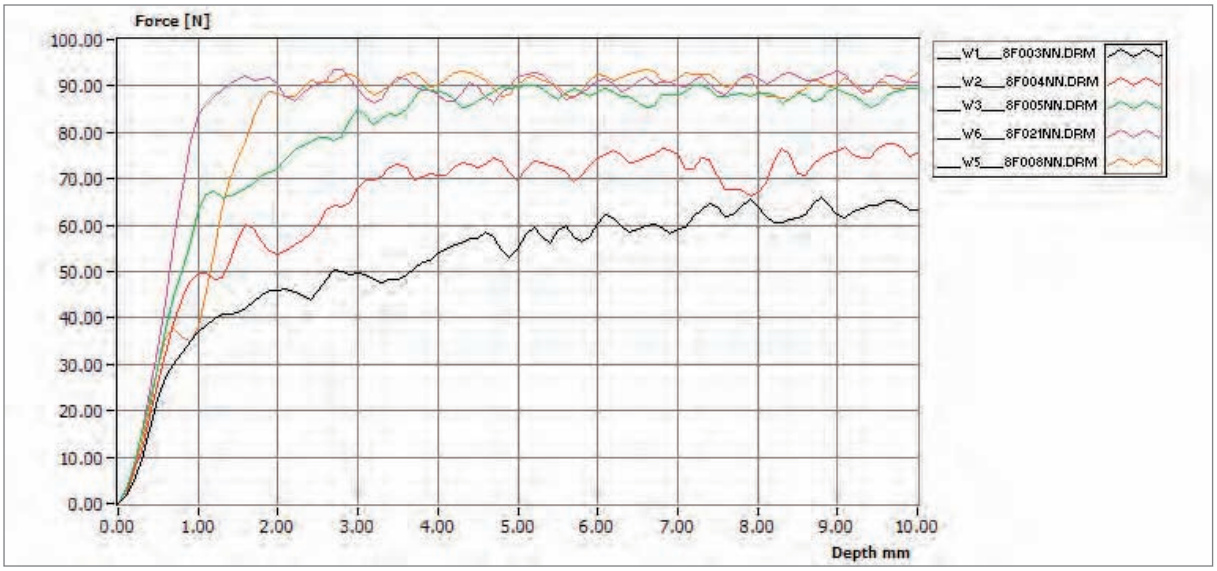



**Abb. 17:** Kurvenverlauf der Bohrhärtemessungen der unbehandelten Proben in z-Richtung / ***Fig. 17:*** *Curve progression of the drill resistance in direction z*

## Mechanische Kennwerte

*Biegezugfestigkeit*

Anhand der Spannungs-Dehnungs-Kurven aus dem biaxialen Biegezugversuch wird die biaxiale Biegezugfestigkeit und der E-Modul ermittelt. Die biaxiale Biegezugfestigkeit entspricht der maximal zu erreichenden Biegespannung während des Versuchs. Dabei wird eine Gesteinsscheibe auf einem Auflagering (Ø 39 mm) positioniert und über einen zweiten kleineren Belastungsring (Ø 13 mm) bis zum Bruch belastet. Die Krafteinleitung erfolgt ringförmig, die unterschiedlichen Ringdurchmesser bewirken eine Biegespannung im Gesteinsgefüge. Die Messungen, deren Ergebnisse auf den Seiten 194 bis 206 im Anhang dargestellt sind, wurden an einer Universalprüfmaschine der Firma Zwick Z010 [Maximalkraft 10 kN] durchgeführt. Die Vorkraft betrug jeweils 10 N und die Belastungszunahme wurde für alle Stufen mit 0,50 mm/Min. definiert. Wie bereits erläutert kann anhand der Biegezugfestigkeitsmessung der E-Modul bestimmt werden.

Für die unbehandelten Gesteinsproben der Jinchuanwan Grotte beträgt der E-Modul 27,6 MPa. Der Wert ist für Sandstein sehr hoch.

*Bohrhärte*

Die Bohrhärtemessungen wurden mit dem Messgerät DRMS cordless der Firma Sint durchgeführt. Verwendet wurden Diaber Diamantbohrer mit einem Durchmesser von 5 mm. Als Referenzmaterial diente Halit, eine klare kristalline und sehr homogene Form des Kochsalzes.[29]

## Mechanical Values

*Biaxial Flexural Strength*

The biaxial flexural strength and the E-modulus are determined according to the tension-tensile curve from the biaxial bending tensile tests. The biaxial flexural strength is the maximum bending tension that can be reached. A stone slice is put on a bearing ring (Ø 39 mm) and put under pressure by a second ring (Ø 13 mm) until it breaks. Circular pressure is applied, and the various radii of the rings effect bending tension of the rock. The measurements, the results of which can be found in the appendix on pages 194 to 206 were carried out using the universal testing machine Z010 (10 kN) from the company Zwick. The preliminary test force was 10 Newton and then additional force was applied in steps of 0.50 mm/min. The E-modulus of the untreated stone sample from the Jinchuanwan grotto was 27.6 MPa. It is a rather high value for sandstone.

*Drilling Resistance*

The drill resistance was tested with a Sint DRMS Cordless. Diaber diamond bits with a radius of 5 mm were used. The reference material used was halite, a clear crystalline and very homogenous form of sodium chloride.

Bevor die erste Bohrung in das Gestein erfolgte, wurde eine Referenzbohrung im Kalibriermaterial Halit durchgeführt. Diese wurde nach jeweils drei Bohrungen im Gestein wiederholt, um den abnutzungsbedingten prozentualen Anstieg der Bohrkraft pro Bohrung zu erfassen.[30] Die Messungen wurden jeweils in z-Richtung durchgeführt. Die Messprotokolle sind im Anhang auf den Seiten 207 bis 215 zu finden.

Es handelt sich bei diesem Sandstein um einen extrem harten, sehr abrasiven Sandstein. In der Auswertung der Messergebnisse zeigte sich, dass die verwendeten Bohrer schon nach ca. fünf Messungen stumpf waren und auch durch Bohrungen in das Referenzmaterial Halite keine vernünftigen Ergebnisse mehr zu erzielen waren. Die Bohrhärte des unbehandelten Gesteins liegt im Bereich von 55 N.

Before the first drilling in the rock, a drilling was made in the halite as a reference. The reference drilling was repeated after every three drillings in the rock to determine the percentual rise of drilling power. This is necessary to compare the wearing effect on the bit per drilling. The measurements were carried out in direction z.

This type of sandstone is extremely hard and very abrasive sandstone. The evaluation of the measurements shows that the drills significant were already blunt after approximately five measurements and that drilling into the reference material halite would not lead to sensible results, either. The drill resistance of the untreated stone is about 55 N. The drilling protocols can be found in the appendix on pages 207 to 215.

## Ergebnisse der behandelten Proben

Die Analyseergebnisse von unbehandeltem und behandeltem Gestein lassen nur dann aussagekräftige Schlüsse zu, wenn die Untersuchungen unter identischen Bedingungen stattfinden. Deswegen wurden sämtliche Laborversuche einerseits nach dem gleichen Schema durchgeführt, andererseits jeweils identische Prüfkörperdimensionen für die Vergleiche von unbehandeltem und behandeltem Gestein herangezogen.

## Results of the Treated Samples

A conclusive analysis of treated and untreated stone can only be reached if the test conditions are identical. Therefore, the tests must be carried out in the same way and the stone samples must be the same size.

### Feuchtekennwerte

*Wasseraufnahme*

Tabelle 12 liefert die aus den Ergebnissen der Wasseraufnahme der Gesteinswürfel bestimmbaren Gesteinskennwerte, wie Porosität, Sättigung, Reindichte und Rohdichte, der mit den Gesteinsfestigern (Seiten 140) behandelten Proben. Die Untersuchungsprotokolle sind diesem Bericht im Anhang auf den Seiten 164 und 165 beigefügt.

### Hygric Values

*Water Absorption*

Table 12 shows the definable results of the water absorption assessment of the stone cubes such as porosity, saturation, particle density and bulk density after they were treated with consolidation products (page 140). The complete results of the analyses can be found in the appendix on pages 164 to 165.

**Tabelle 12:** Ergebnisse der Ermittlung der Wasseraufnahme an den behandelten Würfeln / ***Table 12:*** *Results of water absorption tests on cube samples*

| Sample | Consolidation | WA [Mass %] | WV [Mass %] | Porosity [Vol.%] | Saturation [–] | Particle Density [g/cm³] | Bulk Density [g/cm³] |
|---|---|---|---|---|---|---|---|
| **W7** | KSE OH | 0.80 | 0.98 | 2.55 | 0.82 | 2.66 | 2.6 |
| **W8** | KSE OH | 0.79 | 0.98 | 2.55 | 0.80 | 2.67 | 2.6 |
| **W9** | KSE 100 | 0.85 | 1.02 | 2.66 | 0.83 | 2.67 | 2.6 |
| **W10** | KSE 100 | 0.89 | 0.99 | 2.58 | 0.90 | 2.67 | 2.6 |
| **W11** | KSE 300 | 0.82 | 0.95 | 2.48 | 0.86 | 2.67 | 2.6 |
| **W12** | KSE 300 | 0.77 | 0.92 | 2.38 | 0.84 | 2.66 | 2.6 |

*Hygrische Dilatation*

Die Messdauer der hygrischen Dilatation unter Wasser betrug 48 Stunden. Tabelle 13 zeigt die Mittelwerte der Ergebnisse der hygrischen Dilatation unter Wasser jeweils in x-, y- und z-Richtung. Die Untersuchungsprotokolle mit detaillierten Werten sind diesem Bericht im Anhang auf den Seiten 166 bis 177 beigefügt.

Die Werte sind im Vergleich zu den unbehandelten Proben etwas niedriger, es zeigen sich allerdings nur unmerkliche Unterschiede in der Verwendung der verschiedenen Festigungsmittel.

*Sorptionsisotherme*

Abbildung 18 zeigt jeweils die Mittelwerte für jeden der drei Festigungsmittel für die entsprechende „relative“ Luftfeuchte, die Untersuchungsprotokolle sind diesem Bericht im Anhang auf den Seiten 190 bis 193 beigefügt.

Der Kurvenverlauf der gefestigten Proben zeigt kaum Unterschiede im Vergleich mit den unbehan-

*Hygric Dilatation*

The testing period for dilatation was 48 hours. Table 13 shows the average values of hygric dilatation under water in directions x, y and z. The complete results of the analyses can be found in the appendix on pages 166 to 177.

The values are lower compared to the untreated samples, the different consolidation products show no significant differences.

*Isothermal Line of Sorption*

Figure 18 shows the average values of each of the 3 consolidation products for the respective “relative” humidities; the complete results of the analyses can be found in the appendix on pages 190 to 193.

The curve shape of the consolidated samples hardly shows any differences to the untreated samples. The only difference is the value of the 48 h water storage. The three consolidation products (KSE OH, KSE 100, KSE 300) only show inconsiderable differences.

**Tabelle 13:** Mittelwerte der hygrischen Dilatation unter Wasser und bei 98 % RH für KSE OH, KSE 100 und KSE 300 / ***Table 13:*** *Average values of the hygric dilatation under water at 98 % RH for KSE OH, KSE 100 and KSE 300*

| Direction | Hydric Dilatation (mm/m) | | |
|---|---|---|---|
| | KSE OH | KSE 100 | KSE 300 |
| x | 0.53 | 0.54 | 0.51 |
| y | 0.59 | 0.63 | 0.58 |
| z | 0.73 | 0.75 | 0.73 |

**Tabelle 14:** Thermische Dilatation für KSE OH, KSE 100 und KSE 300 / ***Table 14:*** *Thermal dilatation for KSE OH, KSE 100 and KSE 300*

| Consolidation Product | Thermal Dilatation (mm/m) | | |
|---|---|---|---|
| | x | y | z |
| KSE OH | 0.44 | 0.45 | 0.49 |
| KSE 100 | 0.44 | 0.45 | 0.46 |
| KSE 300 | 0.42 | 0.43 | 0.45 |

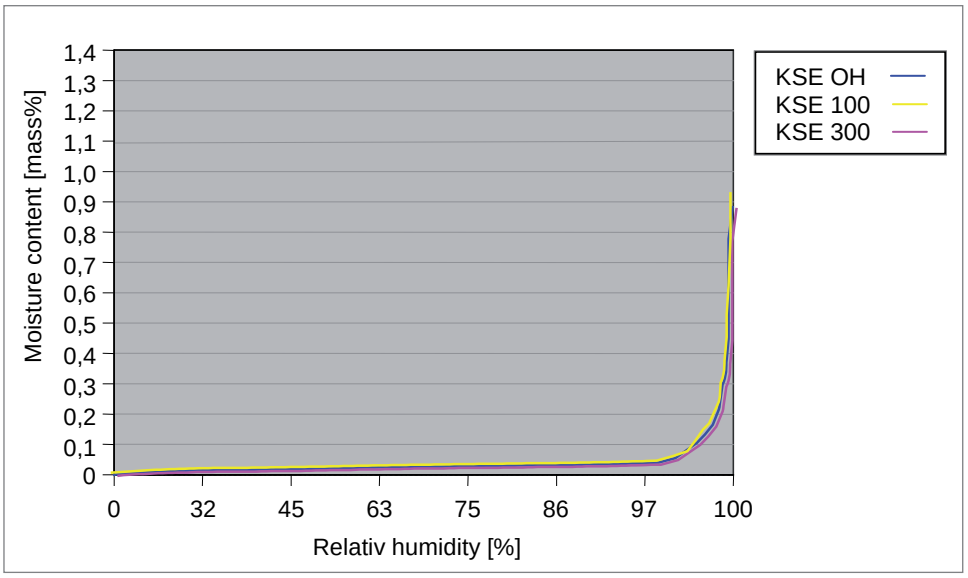



**Abb. 18:** Verlauf der Sorptionsisotherme, ermittelt aus den Mittelwerten der behandelten Gesteinsproben / ***Fig. 18:*** *Progression of the isothermal line of sorption based on the average values of the treated stone samples*

delten Proben. Es unterscheidet sich nur der Wert der 48 Stunden Wasserlagerung. Für die drei Festigungsmittel (KSE OH, KSE 100, KSE 300) ergeben sich nur unwesentliche Unterschiede.

## Thermische Kennwerte

### *Thermische Dilatation*

Die thermische Dilatation zeigt, wie sich das Gestein bei Temperaturänderungen ausdehnt oder zusammenzieht. Die thermische Dilatation wird im Laborversuch ermittelt, indem die Gesteinsprobe auf etwa 60°C erhitzt, in eine Messuhr eingespannt und die bei der Abkühlung auftretende Längenänderung ermittelt wird. Auch die thermische Dilatation wurde in z-, x- und y-Richtung bestimmt. Tabelle 14 liefert im Überblick die Mittelwerte der Untersuchungsergebnisse, die Versuchsprotokolle sind diesem Bericht im Anhang auf den Seiten 178 bis 189 beigefügt.

## Mechanische Kennwerte

### *Biegezugfestigkeit*

Durch die Festigung der Proben ergab sich eine leichte Erhöhung des E-Moduls, bei KSE 300 liegt dieser Wert zwischen dem der unbehandelten Proben und den mit KSE OH und KSE 100 behandelten Proben. Die Messprotokolle sind im Anhang auf den Seiten 194 bis 206 zu finden.

### *Bohrhärte*

Die Bohrhärtemessung wurde an den durchtränkten Proben mit 10 mm Bohrtiefe ausgeführt, für die Proben, die 1 Min./Seite behandelt wurden wurde eine Bohrlochtiefe von 20 mm gewählt um die Eindringtiefe des Festigungsmittels bestimmen zu können. Da das unbehandelte Gestein extrem hart ist, waren die Unterschiede zu den gefestigten Proben nicht darstellbar. Die Bohrhärte liegt für die ungefestigten und gefestigten Proben im Bereich von 55 N. Dieser Wert ist für Sandstein ungewöhnlich hoch und im Regelfall bedürfen solche Steine keiner Festigung. Die Bohrprotokolle sind im Anhang ab Seite 207 dargestellt. Wegen der geringen Porosität des Sandsteins kann auch nur eine geringe Menge an Festigungsmittel aufgenommen werden. Die Erhöhung der Festigkeit fällt daher gering aus und liegt in einer für diese Methode nicht detektierbaren Größenordnung.

**Tabelle 15:** Anhand der Biegezugfestigkeitsmessung ermitteltes E-Modul für KSE OH, KSE 100 und KSE 300 / ***Table 15:*** *E-modulus determined by measurement of flexural strength for KSE OH, KSE 100 and KSE 300*

| | Un-treated | KSE OH | KSE 100 | KSE 300 |
|---|---|---|---|---|
| E-Modulus (kN/mm²) | 27.6 | 30.8 | 30.8 | 28.9 |
| $\delta_{BZ}$ [N/mm²] | 15.5 | 14.0 | 17.2 | 14.8 |

## Thermal Values

### *Thermal Dilatation*

Table 14 shows the average results, the complete results of the analyses can be found in the appendix on pages 178 to 189. There is almost no difference to the untreated samples as expected.

## Mechanical Values

### *Biaxial Flexural Strength*

By consolidating the samples, the E-modulus was increased slightly. The value of samples treated with KSE 300 lies in between the value of the untreated samples and the value of those treated with KSE OH and KSE 100.

### *Drilling Resistance*

Measurement of the drilling resistance was carried out on the soaked samples with a drilling depth of 10 mm; a drilling depth of 20 mm was chosen for the samples that had been treated for 1 minute per side in order to determine the penetration depth of the consolidation product. As the stone is extremely hard, the differences untreated to the consolidated samples were not portrayable. The untreated and treated samples show a drilling resistance of around 55 N. This value is unusually high for sandstone and normally this type of stone would not need consolidating. The protocols of the drillings can be found in the appendix on pages 207 to 215. Only a small amount of the consolidation product can be absorbed due to the low porosity of the sandstone. The increase in strength through consolidation is very slight and can not be detected with these methods.

## Zusammenfassung

Die Laboruntersuchungen wurden mit dem Ziel durchgeführt ein für geplante Konservierungs- und Restaurierungsmaßnahmen geeignetes Festigungsmittel für weitere Versuche in situ auszuwählen.

Das unbehandelte Gestein ist sehr hart, die Unterschiede zu den gefestigten Proben sind daher recht gering. Im Regelfall bedürfen solche Steine keiner Festigung. Es waren durch die Versuche keine wesentlichen Unterschiede zwischen den verschiedenen verwendeten Steinfestigern feststellbar. Aufgrund des guten Eindringverhaltens von KSE OH bei hohem Wirkstoffgehalt bei der Tränkung 1 Min./Seite, wurde dieser den anderen Festigern vorgezogen.

## Summary

The research was done to decide on a consolidation product for further experiments. The untreated stone is very hard; for this reason there are only minor differences compared to the consolidated samples. No considerable differences were detected between the results of the different consolidation products. KSE OH showed the best intrusion behaviour of the consolidation products when treating the cube for one minute each side.

**Tabelle 16:** Gegenüberstellung der Messergebnisse der unbehandelten Probe und der gefestigten Gesteinsproben / ***Table 16:*** *Comparison of the values of the untreated sample to the treated samples*

| **Results** | | **untreated** | **KSE OH** | **KSE 100** | **KSE 300** |
|---|---|---|---|---|---|
| Water absorption | [mass %] | 1.20 | 0.80 | 0.87 | 0.80 |
| Water absorption vacuum | [mass %] | 1.31 | 0.98 | 1.01 | 0.94 |
| Porosity | [Vol.%] | 3.40 | 2.55 | 2.62 | 2.43 |
| Density | [g/cm$^3$] | 2.68 | 2.67 | 2.67 | 2.67 |
| Bulk density | [g/cm$^3$] | 2.59 | 2.60 | 2.60 | 2.60 |
| Isothermal line of sorption | [mass %] | 0.062 | 0.058 | 0.063 | 0.064 |
| Hygric dilatation ⊥ ss | [mm/m] | 0.85 | 0.73 | 0.75 | 0.73 |
| Thermal dilatation ⊥ ss | [mm/m/°C] | 0.47 | 0.49 | 0.46 | 0.45 |
| Biaxial flexural strength | [N/mm²] | 15.5 | 14.0 | 17.2 | 14.5 |
| E-Modulus | [kN/mm$^2$] | 27.6 | 30.8 | 30.8 | 28.9 |
| Drilling resistance | [N] | 55 | 55 | 55 | 55 |
| Health (Danger symbols) | | - | Xi, Xn, F, T | Xn, Xi, T | Xn, Xi, T |
| Environment (WGK) | | - | 2 | 1 | 1 |

**Tabelle 17:** Bewertung der Behandlungsmittel KSE OH, KSE 100 und KSE 300 / ***Table 17:*** *Assessment of the consolidation products KSE OH, KSE 100 and KSE 300*

| **Results** | **KSE OH** | **KSE 100** | **KSE 300** |
|---|---|---|---|
| Water absorption atmosphere | + | + | + |
| Water absorption vacuum | + | + | + |
| Porosity | o | o | o |
| Density | o | o | o |
| Bulk density | o | o | o |
| Isothermal line of sorption | o | o | o |
| Hygric dilatation | + | + | + |
| Hygric dilatation under water | o | o | o |
| Thermal dilatation | o | o | o |
| Biaxial flexural strength | o | o | o |
| E-Modulus | o | o | o |
| Drilling resistance | o | o | o |
| Health | o | + | + |
| Environment | o | + | + |

+ positive Bewertung
o neutrale Bewertung
– negative Bewertung

+ positive assessment
o neutral assessment
– negative assessment

## Endnoten

1 Reinsch 1991.
2 Reinsch 1991.
3 Snethlage 2005.
4 Snethlage 2005.
5 Reinsch 1991.
6 Kocher 2004.
7 Reinsch 1991.
8 Klopfer 1991.
9 Angenheister 1982.
10 Reinsch 1991.
11 Kocher 2004.
12 Kocher 2004.
13 Snethlage 2005.
14 Kocher 2004.
15 Kocher 2004.
16 Reinsch 1991.
17 Reinsch 1991.
18 Kocher 2004.
19 Kocher 2004.
20 Internes Dokument zur Ermittlung mechanischer Kennwerte erstellt von Herrn Tucic.
21 Snethlage 2005.
22 Snethlage 2005.
23 Die technischen Datenblätter der ausgewählten Festigungsmittel sind diesem Bericht in digitaler Form auf der CD ergänzend angefügt.
24 Die technischen Datenblätter der ausgewählten Festigungsmittel sind diesem Bericht in digitaler Form auf der CD ergänzend angefügt.
25 Grassegger 1992.
26 Grassegger 1992.
27 Snethlage 2005.
28 Snethlage 2005.
29 Die vorliegenden Herstellerinformationen liegen diesem Bericht in digitaler Form auf der CD bei.
30 In den im Anhang beigefügten Messwertprotokollen ist der Anstieg als Bereinigung [%] angegeben.

## Endnotes

1 Reinsch 1991.
2 Reinsch 1991.
3 Snethlage 2005.
4 Snethlage 2005.
5 Reinsch 1991.
6 Kocher 2004.
7 Reinsch 1991.
8 Klopfer 1991.
9 Angenheister 1982.
10 Reinsch 1991.
11 Kocher 2004.
12 Kocher 2004.
13 Snethlage 2005.
14 Kocher 2004.
15 Kocher 2004.
16 Reinsch 1991.
17 Reinsch 1991.
18 Kocher 2004.
19 Kocher 2004.
20 Tucic, intern document to deterime mechanical values.
21 Snethlage 2005.
22 Snethlage 2005.
23 cf. technical data sheet on CD.
24 cf. technical data sheet on CD.
25 Grassegger 1992.
26 Grassegger 1992.
27 Snethlage 2005.
28 Snethlage 2005.

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| | |
|---|---|
| DIN 12407 | Prüfverfahren für Naturstein – Petrografische Prüfung, August 2006 |
| DIN EN 13755 | Prüfverfahren für Naturstein – Bestimmung der Wasseraufnahme unter atmosphärischem Druck, Oktober 2007 |
| DIN EN 14581 | Prüfverfahren für Naturstein – Bestimmung des linearen thermischen Ausdehnungskoeffizienten, März 2005 |
| DIN EN 1926 | Prüfverfahren für Naturstein – Bestimmung der einachsigen Druckfestigkeit, März 2007 |
| DIN EN 1936 | Prüfverfahren für Naturstein – Bestimmung der Reindichte, der Rohdichte, der offenen Porosität und der Gesamtporosität, Februar 2007 |
| DIN 52008 | Prüfverfahren für Naturstein – Beurteilung der Verwitterungsbeständigkeit, März 2006 |
| DIN 52009 | Prüfverfahren für Gesteinskörnungen – Bestimmung des Wasseraufnahme unter Druck, Februar 2006 |
| DIN 52100-1 | Naturstein – Gesteinskundliche Untersuchungen – Allgemeines und Übersicht, Juni 2007 |
| DIN 52102 | Prüfverfahren für Gesteinskrönungen – Bestimmung der Trockenrohdichte mit dem Messzylinderverfahren und Berechnung des Dichtigkeitsgrades, Februar 2006 |

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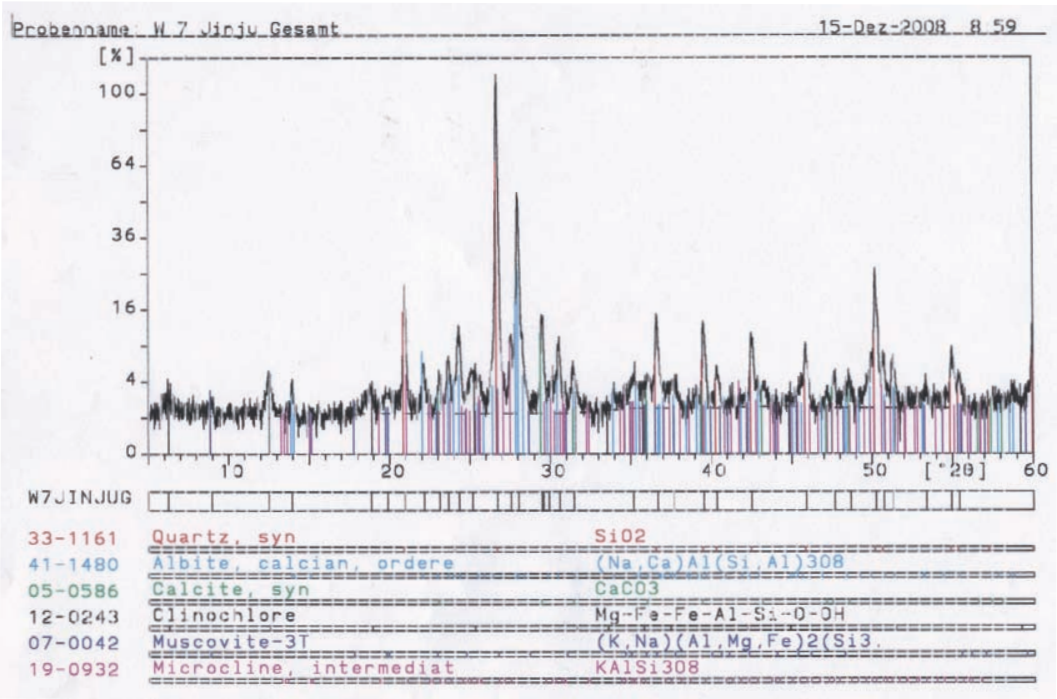
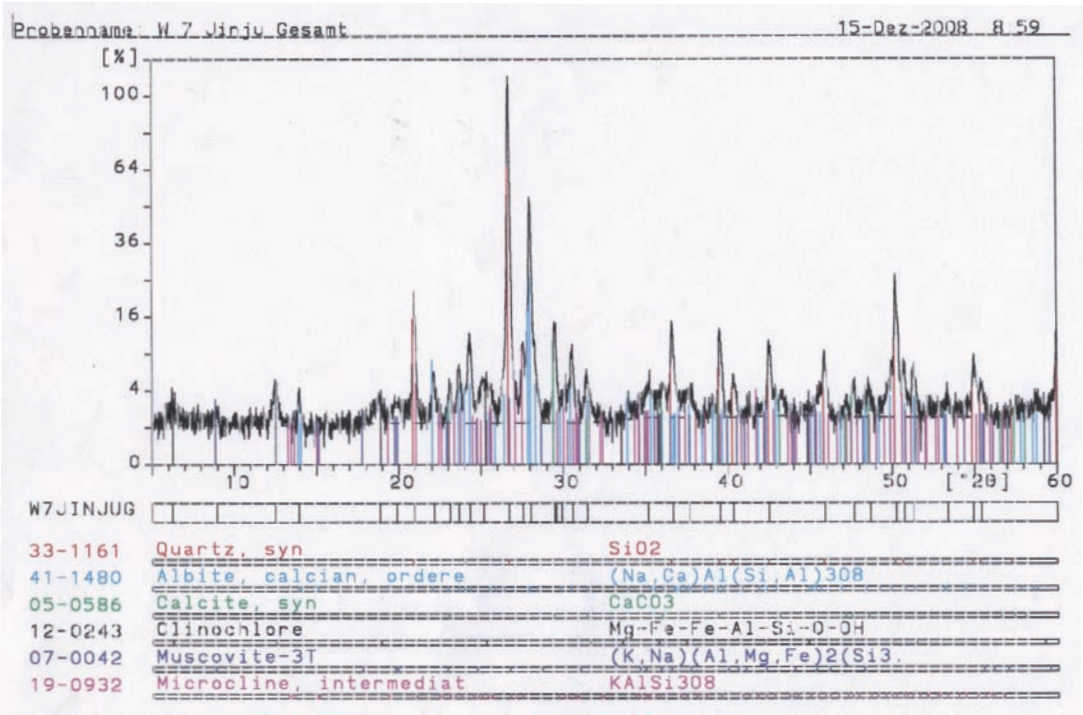
## XRD-Analyse/XRD-Analysis



## Wasseraufnahme/Water Absorption

| Sample | Water absorption | | Water absorption vacuum | | | WA | WA | W. vol. | Poros. | Saturation | Density | Bulk Dens. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | dry weight | wet weight | dry weight | under Water | wet/air | M % | M % | Vol. % | Vol.% | / | g/cm³ | g/cm³ |
| W 1 | 323,210 | 326,749 | 323,052 | 202,257 | 326,928 | 1,09 | 1,2 | 2,84 | 3,11 | 0,91 | 2,67 | 2,59 |
| W 2 | 319,700 | 323,415 | 319,535 | 200,280 | 323,686 | 1,16 | 1,3 | 3,01 | 3,36 | 0,89 | 2,68 | 2,59 |
| W 3 | 323,617 | 327,943 | 323,458 | 203,011 | 328,112 | 1,34 | 1,44 | 3,46 | 3,72 | 0,93 | 2,69 | 2,59 |
| W 7 | 337,167 | 339,877 | 337,167 | 210,613 | 340,475 | 0,8 | 0,98 | 2,09 | 2,55 | 0,82 | 2,66 | 2,6 |
| W 8 | 321,726 | 324,263 | 321,726 | 201,126 | 324,882 | 0,79 | 0,98 | 2,05 | 2,55 | 0,8 | 2,67 | 2,6 |
| W 9 | 329,174 | 331,965 | 329,174 | 205,758 | 332,547 | 0,85 | 1,02 | 2,22 | 2,66 | 0,83 | 2,67 | 2,6 |
| W 10 | 322,279 | 325,142 | 322,279 | 201,462 | 325,476 | 0,89 | 0,99 | 2,31 | 2,58 | 0,9 | 2,67 | 2,6 |
| W 11 | 338,631 | 341,408 | 338,631 | 211,643 | 341,862 | 0,82 | 0,95 | 2,13 | 2,48 | 0,86 | 2,67 | 2,6 |
| W 12 | 334,195 | 336,765 | 334,195 | 208,756 | 337,254 | 0,77 | 0,92 | 2 | 2,38 | 0,84 | 2,66 | 2,6 |
| BK 1 | 88,533 | 88,717 | 88,367 | 55,289 | 88,705 | 0,21 | 0,38 | 0,55 | 1,01 | 0,54 | 2,67 | 2,64 |
| BK 2 | 88,558 | 88,760 | 88,384 | 55,274 | 88,752 | 0,23 | 0,42 | 0,6 | 1,1 | 0,55 | 2,67 | 2,64 |
| BK 3 | 89,402 | 89,594 | 89,263 | 55,793 | 89,595 | 0,21 | 0,37 | 0,57 | 0,98 | 0,58 | 2,67 | 2,64 |

## Ermittlung W-Wert/Water Absorption Coefficient

**W1**

**mass:** m= 322,94 g
**area:** A= 0,002500 m²

| t [sec] | t [h^0,5] | m [g] | [kg/m²] |
|---|---|---|---|
| 30 | 0,091287 | 323,07 | 0,04920 |
| 60 | 0,129099 | 323,09 | 0,05920 |
| 120 | 0,182574 | 323,11 | 0,06480 |
| 300 | 0,288675 | 323,14 | 0,07760 |
| 600 | 0,408248 | 323,17 | 0,09120 |
| 1200 | 0,577350 | 323,22 | 0,11200 |
| 1800 | 0,707107 | 323,26 | 0,12440 |
| 3600 | 1,000000 | 323,35 | 0,16040 |

**w-value = 0,12**

**W2**

**mass:** m= 319,48 g
**area:** A= 0,002500 m²

| t [sec] | t [h^0,5] | m [g] | [kg/m²] |
|---|---|---|---|
| 30 | 0,091287 | 319,57 | 0,03680 |
| 60 | 0,129099 | 319,58 | 0,04240 |
| 120 | 0,182574 | 319,60 | 0,05000 |
| 300 | 0,288675 | 319,64 | 0,06280 |
| 600 | 0,408248 | 319,67 | 0,07680 |
| 1200 | 0,577350 | 319,72 | 0,09600 |
| 1800 | 0,707107 | 319,75 | 0,10960 |
| 3600 | 1,000000 | 319,85 | 0,14680 |

**w-value = 0,12**

**W3**

**mass:** m= 323,40 g
**area:** A= 0,002500 m²

| t [sec] | t [h^0,5] | m [g] | [kg/m²] |
|---|---|---|---|
| 30 | 0,091287 | 323,48 | 0,03080 |
| 60 | 0,129099 | 323,49 | 0,03760 |
| 120 | 0,182574 | 323,52 | 0,04920 |
| 300 | 0,288675 | 323,55 | 0,06080 |
| 600 | 0,408248 | 323,58 | 0,07040 |
| 1200 | 0,577350 | 323,64 | 0,09400 |
| 1800 | 0,707107 | 323,68 | 0,11080 |
| 3600 | 1,000000 | 323,78 | 0,15280 |

**w-value = 0,13**

**W7**

| | | | |
|---|---|---|---|
| **mass:** | m= | 337,45 | g |
| **area:** | A= | 0,002500 | m² |

| t [sec] | t [h^0,5] | m [g] | [kg/m²] |
|---|---|---|---|
| 30 | 0,091287 | 337,50 | 0,01960 |
| 60 | 0,129099 | 337,51 | 0,02640 |
| 120 | 0,182574 | 337,52 | 0,02800 |
| 300 | 0,288675 | 337,53 | 0,03200 |
| 600 | 0,408248 | 337,54 | 0,03840 |
| 1200 | 0,577350 | 337,57 | 0,04760 |
| 1800 | 0,707107 | 337,59 | 0,05680 |
| 3600 | 1,000000 | 337,64 | 0,07600 |

**w-value = 0,06**

**W8**

| | | | |
|---|---|---|---|
| **mass:** | m= | 321,85 | g |
| **area:** | A= | 0,002500 | m² |

| t [sec] | t [h^0,5] | m [g] | [kg/m²] |
|---|---|---|---|
| 30 | 0,091287 | 321,89 | 0,01680 |
| 60 | 0,129099 | 321,90 | 0,01960 |
| 120 | 0,182574 | 321,91 | 0,02440 |
| 300 | 0,288675 | 321,92 | 0,02760 |
| 600 | 0,408248 | 321,93 | 0,03400 |
| 1200 | 0,577350 | 321,94 | 0,03560 |
| 1800 | 0,707107 | 321,95 | 0,04240 |
| 3600 | 1,000000 | 321,98 | 0,05160 |

**w-value = 0,04**

**W9**

| | | | |
|---|---|---|---|
| **mass:** | m= | 329,24 | g |
| **area:** | A= | 0,002500 | m² |

| t [sec] | t [h^0,5] | m [g] | [kg/m²] |
|---|---|---|---|
| 30 | 0,091287 | 329,27 | 0,01040 |
| 60 | 0,129099 | 329,29 | 0,01720 |
| 120 | 0,182574 | 329,30 | 0,02120 |
| 300 | 0,288675 | 329,32 | 0,02920 |
| 600 | 0,408248 | 329,33 | 0,03520 |
| 1200 | 0,577350 | 329,35 | 0,04480 |
| 1800 | 0,707107 | 329,37 | 0,05240 |
| 3600 | 1,000000 | 329,42 | 0,07040 |

**w-value = 0,06**

**W10**

| | | | |
|---|---|---|---|
| **mass:** | m= | 322,31 | g |
| **area:** | A= | 0,002500 | m² |

| t [sec] | t [h^0,5] | m [g] | [kg/m²] |
|---|---|---|---|
| 30 | 0,091287 | 322,36 | 0,01960 |
| 60 | 0,129099 | 322,37 | 0,02280 |
| 120 | 0,182574 | 322,38 | 0,02720 |
| 300 | 0,288675 | 322,40 | 0,03560 |
| 600 | 0,408248 | 322,41 | 0,04120 |
| 1200 | 0,577350 | 322,44 | 0,05280 |
| 1800 | 0,707107 | 322,46 | 0,05920 |
| 3600 | 1,000000 | 322,52 | 0,08240 |

**w-value = 0,07**

**W11**

| | | | |
|---|---|---|---|
| **mass:** | m= | 338,78 | g |
| **area:** | A= | 0,002500 | m² |

| t [sec] | t [h^0,5] | m [g] | [kg/m²] |
|---|---|---|---|
| 30 | 0,091287 | 338,82 | 0,01800 |
| 60 | 0,129099 | 338,84 | 0,02520 |
| 120 | 0,182574 | 338,85 | 0,02680 |
| 300 | 0,288675 | 338,86 | 0,03120 |
| 600 | 0,408248 | 338,86 | 0,03400 |
| 1200 | 0,577350 | 338,89 | 0,04320 |
| 1800 | 0,707107 | 338,90 | 0,04800 |
| 3600 | 1,000000 | 338,93 | 0,05840 |

**w-value = 0,04**

**W12**

| | | | |
|---|---|---|---|
| **mass:** | m= | 334,20 | g |
| **area:** | A= | 0,002500 | m² |

| t [sec] | t [h^0,5] | m [g] | [kg/m²] |
|---|---|---|---|
| 30 | 0,091287 | 334,24 | 0,01240 |
| 60 | 0,129099 | 334,24 | 0,01400 |
| 120 | 0,182574 | 334,25 | 0,01760 |
| 300 | 0,288675 | 334,26 | 0,02160 |
| 600 | 0,408248 | 334,27 | 0,02680 |
| 1200 | 0,577350 | 334,28 | 0,03160 |
| 1800 | 0,707107 | 334,30 | 0,03720 |
| 3600 | 1,000000 | 334,33 | 0,04960 |

**w-value = 0,04**

## Hygrische Dilatation/Hygric Dilatation

| **Hygric Dilatation** | | | |
|---|---|---|---|
| **Sample** | W1, Jinchuanwan Grotto | | |
| **Comment** | stone cube untreated | | |
| **Direction** | x | y | z |
| **Date** | 2.–4.3.2009 | 9.–11.3.2009 | 16.–18.3.2009 |
| **Temperature** | 23°C | 24°C | 24°C |
| **Relative humidity** | 36 % | 37 % | 37 % |
| **Length [mm]** | 49,97 | 49,63 | 50,24 |
| **$m_0$ [g]** | 323,251 | 323,740 | 323,574 |
| **$m_1$ [g]** | | 326,951 | 326,915 |
| **Water uptake [g]** | | 3,211 | 3,341 |
| **Dial gauge** | 1 | 1 | 1 |

| **Date** | **Time** | **Δ l [mm]** | **Δ l / l [mm/m]** | **Comment** |
|---|---|---|---|---|
| 23.3.2009 | 12.15 | 0,000 | 0,560 | x-direction |
| | 13.45 | 0,002 | | |
| | 15.30 | 0,004 | | |
| 4.3.2009 | 10.00 | 0,028 | | |
| | 12.15 | 0,028 | | |
| 9.3.2009 | 7.20 | 0,000 | 0,544 | y-direction |
| | 13.00 | 0,004 | | |
| 10.3.2009 | 7.30 | 0,016 | | |
| 11.3.2009 | 7.20 | 0,027 | | |
| 16.3.2009 | 7.30 | 0,000 | 0,736 | z-direction |
| | 10.15 | 0,004 | | |
| | 16.00 | 0,010 | | |
| 17.3.2009 | 8.00 | 0,026 | | |
| 18.3.2009 | 7.45 | 0,037 | | |

| **Hygric Dilatation** | | | |
|---|---|---|---|
| **Sample** | W2, Jinchuanwan Grotto | | |
| **Comment** | stone cube untreated | | |
| **Direction** | x | y | z |
| **Date** | 2.–4.3.2009 | 9.–11.3.2009 | 16.–18.3.2009 |
| **Temperature** | 23°C | 24°C | 24°C |
| **Relative humidity** | 36 % | 37 % | 37 % |
| **Length [mm]** | 50,42 | 49,47 | 50,07 |
| **$m_0$ [g]** | 319,732 | 320,241 | 320,071 |
| **$m_1$ [g]** | | 323,552 | 323,505 |
| **Water uptake [g]** | | 3,311 | 3,434 |
| **Dial gauge** | 2 | 2 | 2 |

| **Date** | **Time** | **Δ l [mm]** | **Δ l / l [mm/m]** | **Comment** |
|---|---|---|---|---|
| 23.3.2009 | 12.15 | 0,000 | 0,575 | x-direction |
| | 13.45 | 0,003 | | |
| | 15.30 | 0,005 | | |
| 4.3.2009 | 10.00 | 0,029 | | |
| | 12.15 | 0,029 | | |
| 9.3.2009 | 7.20 | 0,000 | 0,667 | y-direction |
| | 13.00 | 0,005 | | |
| 10.3.2009 | 7.30 | 0,020 | | |
| 11.3.2009 | 7.20 | 0,033 | | |
| 16.3.2009 | 7.30 | 0,000 | 0,789 | z-direction |
| | 10.15 | 0,007 | | |
| | 16.00 | 0,008 | | |
| 17.3.2009 | 8.00 | 0,025 | | |
| 18.3.2009 | 7.45 | 0,040 | | |

| **Hygric Dilatation** | | | |
|---|---|---|---|
| **Sample** | W3, Jinchuanwan Grotto | | |
| **Comment** | stone cube untreated | | |
| **Direction** | x | y | z |
| **Date** | 2.–4.3.2009 | 9.–11.3.2009 | 16.–18.3.2009 |
| **Temperature** | 23°C | 24°C | 24°C |
| **Relative humidity** | 36 % | 37 % | 37 % |
| **Length [mm]** | 50,47 | 50,99 | 49,36 |
| **$m_0$ [g]** | 323,654 | 324,237 | 323,928 |
| **$m_1$ [g]** | | 327,795 | 327,797 |
| **Water uptake [g]** | | 3,558 | 3,869 |
| **Dial gauge** | 3 | 3 | 3 |

| **Date** | **Time** | **Δ l [mm]** | **Δ l / l [mm/m]** | **Comment** |
|---|---|---|---|---|
| 23.3.2009 | 12.15 | 0,000 | 0,674 | x-direction |
| | 13.45 | 0,003 | | |
| | 15.30 | 0,005 | | |
| 4.3.2009 | 10.00 | 0,034 | | |
| | 12.15 | 0,034 | | |
| 9.3.2009 | 7.20 | 0,000 | 0,727 | y-direction |
| | 13.00 | 0,008 | | |
| 10.3.2009 | 7.30 | 0,029 | | |
| 11.3.2009 | 7.20 | 0,037 | | |
| 16.3.2009 | 7.30 | 0,000 | 0,891 | z-direction |
| | 10.15 | 0,003 | | |
| | 16.00 | 0,007 | | |
| 17.3.2009 | 8.00 | 0,028 | | |
| 18.3.2009 | 7.45 | 0,044 | | |

| **Hygric Dilatation** | | | |
|---|---|---|---|
| **Sample** | W4, Jinchuanwan Grotto | | |
| **Comment** | stone cube untreated | | |
| **Direction** | x | y | z |
| **Date** | 2.–4.3.2009 | 9.–11.3.2009 | 16.–18.3.2009 |
| **Temperature** | 23°C | 24°C | 24°C |
| **Relative humidity** | 36 % | 37 % | 37 % |
| **Length [mm]** | 50,84 | 51,70 | 49,39 |
| **$m_0$ [g]** | 330,352 | 330,905 | 330,685 |
| **$m_1$ [g]** | | 334,361 | 334,337 |
| **Water uptake [g]** | | 3,456 | 3,652 |
| **Dial gauge** | 4 | 5 | 5 |

| **Date** | **Time** | **Δ l [mm]** | **Δ l / l [mm/m]** | **Comment** |
|---|---|---|---|---|
| 23.3.2009 | 12.15 | 0,000 | 0,551 | x-direction |
| | 13.45 | 0,002 | | |
| | 15.30 | 0,003 | | |
| 4.3.2009 | 10.00 | 0,028 | | |
| | 12.15 | 0,028 | | |
| 9.3.2009 | 7.20 | 0,000 | 0,638 | y-direction |
| | 13.00 | 0,002 | | |
| 10.3.2009 | 7.30 | 0,026 | | |
| 11.3.2009 | 7.20 | 0,033 | | |
| 16.3.2009 | 7.30 | 0,000 | 0,850 | z-direction |
| | 10.15 | 0,002 | | |
| | 16.00 | 0,004 | | |
| 17.3.2009 | 8.00 | 0,030 | | |
| 18.3.2009 | 7.45 | 0,042 | | |

| **Hygric Dilatation** | | | |
|---|---|---|---|
| **Sample** | W5, Jinchuanwan Grotto | | |
| **Comment** | stone cube untreated | | |
| **Direction** | x | y | z |
| **Date** | 2.–4.3.2009 | 9.–11.3.2009 | 16.–18.3.2009 |
| **Temperature** | 23°C | 24°C | 24°C |
| **Relative humidity** | 36 % | 37 % | 37 % |
| **Length [mm]** | 50,38 | 49,68 | 49,89 |
| **$m_0$ [g]** | 316,974 | 317,454 | 317,300 |
| **$m_1$ [g]** | | 320,491 | 320,493 |
| **Water uptake [g]** | | 3,037 | 3,193 |
| **Dial gauge** | 5 | 6 | 6 |

| **Date** | **Time** | **Δ l [mm]** | **Δ l / l [mm/m]** | **Comment** |
|---|---|---|---|---|
| 23.3.2009 | 12.15 | 0,000 | 0,576 | x-direction |
| | 13.45 | 0,002 | | |
| | 15.30 | 0,004 | | |
| 4.3.2009 | 10.00 | 0,029 | | |
| | 12.15 | 0,029 | | |
| 9.3.2009 | 7.20 | 0,000 | 0,705 | y-direction |
| | 13.00 | 0,006 | | |
| 10.3.2009 | 7.30 | 0,028 | | |
| 11.3.2009 | 7.20 | 0,035 | | |
| 16.3.2009 | 7.30 | 0,000 | 0,862 | z-direction |
| | 10.15 | 0,003 | | |
| | 16.00 | 0,008 | | |
| 17.3.2009 | 8.00 | 0,028 | | |
| 18.3.2009 | 7.45 | 0,043 | | |

| **Hygric Dilatation** | | | |
|---|---|---|---|
| **Sample** | W6, Jinchuanwan Grotto | | |
| **Comment** | stone cube untreated | | |
| **Direction** | x | y | z |
| **Date** | 2.–4.3.2009 | 9.–11.3.2009 | 16.–18.3.2009 |
| **Temperature** | 23°C | 24°C | 24°C |
| **Relative humidity** | 36 % | 37 % | 37 % |
| **Length [mm]** | 50,12 | 51,44 | 49,89 |
| **$m_0$ [g]** | 329,352 | 329,838 | 329,555 |
| **$m_1$ [g]** | | 333,310 | 333,329 |
| **Water uptake [g]** | | 3,472 | 3,774 |
| **Dial gauge** | 6 | 4 | 4 |

| **Date** | **Time** | **Δ l [mm]** | **Δ l / l [mm/m]** | **Comment** |
|---|---|---|---|---|
| 2.3.2009 | 12.15 | 0,000 | 0,718 | x-direction |
| | 13.45 | 0,003 | | |
| | 15.30 | 0,005 | | |
| 4.3.2009 | 10.00 | 0,036 | | |
| | 12.15 | 0,036 | | |
| 9.3.2009 | 7.20 | 0,000 | 0,719 | y-direction |
| | 13.00 | 0,007 | | |
| 10.3.2009 | 7.30 | 0,030 | | |
| 11.3.2009 | 7.20 | 0,037 | | |
| 16.3.2009 | 7.30 | 0,000 | 0,982 | z-direction |
| | 10.15 | 0,004 | | |
| | 16.00 | 0,013 | | |
| 17.3.2009 | 8.00 | 0,044 | | |
| 18.3.2009 | 7.45 | 0,049 | | |

| **Hygric Dilatation** | | | |
|---|---|---|---|
| **Sample** | W7, Jinchuanwan Grotto | | |
| **Comment** | stone cube, soaked KSE–OH | | |
| **Direction** | x | y | z |
| **Date** | 4.–6.3.2009 | 11.–13.3.2009 | 18.–20.3.2009 |
| **Temperature** | 23°C | 24°C | 23°C |
| **Relative humidity** | 37 % | 37 % | 38 % |
| **Length [mm]** | 50,03 | 52,70 | 50,44 |
| **$m_0$ [g]** | 336,540 | 336,630 | 336,360 |
| **$m_1$ [g]** | 339,627 | 339,907 | 339,755 |
| **Water uptake [g]** | 3,087 | 3,277 | 3,395 |
| **Dial gauge** | 1 | 1 | 1 |

| **Date** | **Time** | **Δ l [mm]** | **Δ l / l [mm/m]** | **Comment** |
|---|---|---|---|---|
| 4.3.2009 | 12.30 | 0,000 | 0,540 | x-direction |
| | 16.30 | 0,001 | | |
| 5.3.2009 | 10.30 | 0,015 | | |
| 6.3.2009 | 12.30 | 0,027 | | |
| 11.3.2009 | 7.45 | 0,000 | 0,569 | y-direction |
| | 13.00 | 0,005 | | |
| | 17.30 | 0,008 | | |
| 12.3.2009 | 7.30 | 0,021 | | |
| 13.2.2009 | 7.45 | 0,030 | | |
| 18.3.2009 | 8.00 | 0,000 | 0,734 | z-direction |
| | 12.00 | 0,001 | | |
| | 15.50 | 0,005 | | |
| 19.3.2009 | 10.15 | 0,029 | | |
| 20.3.2009 | 8.00 | 0,037 | | |

| **Hygric Dilatation** | | | |
|---|---|---|---|
| **Sample** | W8, Jinchuanwan Grotto | | |
| **Comment** | stone cube, KSE OH 1 min/side | | |
| **Direction** | x | y | z |
| **Date** | 4.–6.3.2009 | 11.–13.3.2009 | 18.–20.3.2009 |
| **Temperature** | 23°C | 24°C | 23°C |
| **Relative humidity** | 37 % | 37 % | 38 % |
| **Length [mm]** | 50,37 | 49,64 | 50,04 |
| **$m_0$ [g]** | 321,177 | 321,343 | 321,092 |
| **$m_1$ [g]** | 324,224 | 324,443 | 324,335 |
| **Water uptake [g]** | 3,047 | 3,100 | 3,263 |
| **Dial gauge** | 2 | 2 | 2 |

| **Date** | **Time** | **Δ l [mm]** | **Δ l / l [mm/m]** | **Comment** |
|---|---|---|---|---|
| 4.3.2009 | 12.30 | 0,0000 | 0,516 | x-direction |
| | 16.30 | 0,001 | | |
| 5.3.2009 | 10.30 | 0,012 | | |
| 6.3.2009 | 12.30 | 0,026 | | |
| 11.3.2009 | 7.45 | 0,000 | 0,604 | y-direction |
| | 13.00 | 0,002 | | |
| | 17.30 | 0,005 | | |
| 12.3.2009 | 7.30 | 0,019 | | |
| 13.2.2009 | 7.45 | 0,030 | | |
| 18.3.2009 | 8.00 | 0,000 | 0,699 | z-direction |
| | 12.00 | 0,005 | | |
| | 15.50 | 0,009 | | |
| 19.3.2009 | 10.15 | 0,025 | | |
| 20.3.2009 | 8.00 | 0,035 | | |

| **Hygric Dilatation** | | | |
|---|---|---|---|
| **Sample** | W9, Jinchuanwan Grotto | | |
| **Comment** | stone cube, soaked KSE 100 | | |
| **Direction** | x | y | z |
| **Date** | 4.–6.3.2009 | 11.–13.3.2009 | 18.–20.3.2009 |
| **Temperature** | 23°C | 24°C | 23°C |
| **Relative humidity** | 37 % | 37 % | 38 % |
| **Length [mm]** | 50,26 | 51,50 | 49,76 |
| **$m_0$ [g]** | 328,343 | 328,538 | 328,211 |
| **$m_1$ [g]** | 331,739 | 331,971 | 331,887 |
| **Water uptake [g]** | 3,396 | 3,433 | 3,676 |
| **Dial gauge** | 3 | 3 | 3 |

| **Date** | **Time** | **Δ l [mm]** | **Δ l / l [mm/m]** | **Comment** |
|---|---|---|---|---|
| 4.3.2009 | 12.30 | 0,000 | 0,557 | x-direction |
| | 16.30 | 0,002 | | |
| 5.3.2009 | 10.30 | 0,018 | | |
| 6.3.2009 | 12.30 | 0,028 | | |
| 11.3.2009 | 7.45 | 0,000 | 0,680 | y-direction |
| | 13.00 | 0,002 | | |
| | 17.30 | 0,006 | | |
| 12.3.2009 | 7.30 | 0,023 | | |
| 13.2.2009 | 7.45 | 0,035 | | |
| 18.3.2009 | 8.00 | 0,000 | 0,804 | z-direction |
| | 12.00 | 0,005 | | |
| | 15.50 | 0,008 | | |
| 19.3.2009 | 10.15 | 0,028 | | |
| 20.3.2009 | 8.00 | 0,040 | | |

| **Hygric Dilatation** | | | |
|---|---|---|---|
| **Sample** | W10, Jinchuanwan Grotto | | |
| **Comment** | stone cube, KSE 100 1 min/side | | |
| **Direction** | x | y | z |
| **Date** | 4.–6.3.2009 | 11.–13.3.2009 | 18.–20.3.2009 |
| **Temperature** | 23°C | 24°C | 23°C |
| **Relative humidity** | 37 % | 37 % | 38 % |
| **Length [mm]** | 49,83 | 50,65 | 49,90 |
| **$m_0$ [g]** | 321,615 | 321,719 | 321,475 |
| **$m_1$ [g]** | 324,730 | 324,909 | 324,800 |
| **Water uptake [g]** | 3,115 | 3,190 | 3,325 |
| **Dial gauge** | 4 | 5 | 5 |

| **Date** | **Time** | **Δ l [mm]** | **Δ l / l [mm/m]** | **Comment** |
|---|---|---|---|---|
| 4.3.2009 | 12.30 | 0,000 | 0,522 | x-direction |
| | 16.30 | 0,002 | | |
| 5.3.2009 | 10.30 | 0,017 | | |
| 6.3.2009 | 12.30 | 0,026 | | |
| 11.3.2009 | 7.45 | 0,000 | 0,573 | y-direction |
| | 13.00 | 0,005 | | |
| | 17.30 | 0,008 | | |
| 12.3.2009 | 7.30 | 0,019 | | |
| 13.2.2009 | 7.45 | 0,029 | | |
| 18.3.2009 | 8.00 | 0,000 | 0,701 | z-direction |
| | 12.00 | 0,001 | | |
| | 15.50 | 0,003 | | |
| 19.3.2009 | 10.15 | 0,021 | | |
| 20.3.2009 | 8.00 | 0,035 | | |

| **Hygric Dilatation** | | | |
|---|---|---|---|
| **Sample** | W11, Jinchuanwan Grotto | | |
| **Comment** | stone cube, KSE 300 1 min/side | | |
| **Direction** | x | y | z |
| **Date** | 4.–6.3.2009 | 11.–13.3.2009 | 18.–20.3.2009 |
| **Temperature** | 23°C | 24°C | 23°C |
| **Relative humidity** | 37 % | 37 % | 38 % |
| **Length [mm]** | 50,75 | 51,62 | 50,21 |
| **$m_0$ [g]** | 337,954 | 338,139 | 337,878 |
| **$m_1$ [g]** | 341,118 | 341,326 | 341,226 |
| **Water uptake [g]** | 3,164 | 3,187 | 3,348 |
| **Dial gauge** | 5 | 6 | 6 |

| **Date** | **Time** | **Δ l [mm]** | **Δ l / l [mm/m]** | **Comment** |
|---|---|---|---|---|
| 4.3.2009 | 12.30 | 0,000 | 0,512 | x-direction |
| | 16.30 | 0,001 | | |
| 5.3.2009 | 10.30 | 0,013 | | |
| 6.3.2009 | 12.30 | 0,026 | | |
| 11.3.2009 | 7.45 | 0,000 | 0,562 | y-direction |
| | 13.00 | 0,002 | | |
| | 17.30 | 0,004 | | |
| 12.3.2009 | 7.30 | 0,017 | | |
| 13.2.2009 | 7.45 | 0,029 | | |
| 18.3.2009 | 8.00 | 0,000 | 0,657 | z-direction |
| | 12.00 | 0,001 | | |
| | 15.50 | 0,004 | | |
| 19.3.2009 | 10.15 | 0,019 | | |
| 20.3.2009 | 8.00 | 0,033 | | |

| **Hygric Dilatation** | | | |
|---|---|---|---|
| **Sample** | W12, Jinchuanwan Grotto | | |
| **Comment** | stone cube, soaked KSE 300 | | |
| **Direction** | x | y | z |
| **Date** | 4.–6.3.2009 | 11.–13.3.2009 | 18.–20.3.2009 |
| **Temperature** | 23°C | 24°C | 23°C |
| **Relative humidity** | 37 % | 37 % | 38 % |
| **Length [mm]** | 50,88 | 50,43 | 50,55 |
| **$m_0$ [g]** | 333,348 | 333,615 | 333,271 |
| **$m_1$ [g]** | 336,684 | 336,874 | 336,737 |
| **Water uptake [g]** | 3,336 | 3,259 | 3,466 |
| **Dial gauge** | 6 | 4 | 4 |

| **Date** | **Time** | **Δ l [mm]** | **Δ l / l [mm/m]** | **Comment** |
|---|---|---|---|---|
| 4.3.2009 | 12.30 | 0,000 | 0,512 | x-direction |
| | 16.30 | 0,001 | | |
| 5.3.2009 | 10.30 | 0,016 | | |
| 6.3.2009 | 12.30 | 0,026 | | |
| 11.3.2009 | 7.45 | 0,000 | 0,595 | y-direction |
| | 13.00 | 0,004 | | |
| | 17.30 | 0,008 | | |
| 12.3.2009 | 7.30 | 0,023 | | |
| 13.2.2009 | 7.45 | 0,030 | | |
| 18.3.2009 | 8.00 | 0,000 | 0,811 | z-direction |
| | 12.00 | 0,002 | | |
| | 15.50 | 0,014 | | |
| 19.3.2009 | 10.15 | 0,035 | | |
| 20.3.2009 | 8.00 | 0,041 | | |

## Thermische Dilatation/Thermal Dilatation

| **Thermal Dilatation** | | | |
|---|---|---|---|
| **Sample** | W1, Jinchuanwan Grotto | | |
| **Comment** | stone cube untreated | | |
| **Direction** | x | y | z |
| **Date** | 16.2.2009 | 23.2.2009 | 25.2.2009 |
| **Temperature** | 24°C | 23°C | 24°C |
| **Relative humidity** | 28 % | 33 % | 32 % |
| **Start temperature** | 62°C | 62°C | 62°C |
| **Length [mm]** | 49,97 | 49,63 | 50,24 |
| **$m_0$ [g]** | 322,992 | 322,814 | 322,801 |
| **$m_1$ [g]** | 323,110 | 323,121 | 323,102 |
| **Dial gauge** | 1 | 1 | 1 |

| **Date** | **Time** | **Δ l [mm]** | **Δ l / l [mm/m]** | **Comment** |
|---|---|---|---|---|
| 16.2.2009 | 7.51 | 0,000 | 0,440 | x-direction |
| | 8.08 | 0,013 | | |
| | 8.23 | 0,019 | | |
| | 8.53 | 0,022 | | |
| | 9.53 | 0,023 | | |
| | 11.53 | 0,022 | | |
| | 15.50 | 0,022 | | |
| 23.2.2009 | 7.32 | 0,000 | 0,443 | y-direction |
| | 7.45 | 0,012 | | |
| | 8.02 | 0,022 | | |
| | 8.30 | 0,024 | | |
| | 9.30 | 0,024 | | |
| | 11.30 | 0,023 | | |
| | 13.30 | 0,022 | | |
| | 16.00 | 0,022 | | |
| 25.2.2009 | 7.55 | 0,000 | 0,478 | z-direction |
| | 8.05 | 0,008 | | |
| | 8.25 | 0,022 | | |
| | 9.00 | 0,024 | | |
| | 10.00 | 0,024 | | |
| | 12.00 | 0,024 | | |
| | 14.00 | 0,024 | | |
| | 16.00 | 0,024 | | |

| | **Δ l / l [mm/m]** | **Δ l /ΔT [µm/°C]** |
|---|---|---|
| x-direction | 0,440 | 11,58 |
| y-direction | 0,443 | 11,36 |
| z-direction | 0,478 | 12,58 |

| **Thermal Dilatation** | | | |
|---|---|---|---|
| **Sample** | W2, Jinchuanwan Grotto | | |
| **Comment** | stone cube untreated | | |
| **Direction** | x | y | z |
| **Date** | 16.2.2009 | 23.2.2009 | 25.2.2009 |
| **Temperature** | 24°C | 23°C | 24°C |
| **Relative humidity** | 28 % | 33 % | 32 % |
| **Start temperature** | 62°C | 62°C | 62°C |
| **Length [mm]** | 50,42 | 49,47 | 50,07 |
| **$m_0$ [g]** | 319,479 | 319,469 | 319,297 |
| **$m_1$ [g]** | 319,593 | 319,608 | 319,551 |
| **Dial gauge** | 2 | 2 | 2 |

| **Date** | **Time** | **Δ l [mm]** | **Δ l / l [mm/m]** | **Comment** |
|---|---|---|---|---|
| 16.2.2009 | 7.52 | 0,000 | 0,456 | x-direction |
| | 8.08 | 0,014 | | |
| | 8.23 | 0,021 | | |
| | 8.53 | 0,023 | | |
| | 9.53 | 0,024 | | |
| | 11.53 | 0,023 | | |
| | 15.50 | 0,023 | | |
| 23.2.2009 | 7.32 | 0,000 | 0,465 | y-direction |
| | 7.45 | 0,014 | | |
| | 8.02 | 0,018 | | |
| | 8.30 | 0,022 | | |
| | 9.30 | 0,022 | | |
| | 11.30 | 0,023 | | |
| | 13.30 | 0,023 | | |
| | 16.00 | 0,023 | | |
| 25.2.2009 | 7.55 | 0,000 | 0,459 | z-direction |
| | 8.05 | 0,008 | | |
| | 8.25 | 0,022 | | |
| | 9.00 | 0,024 | | |
| | 10.00 | 0,024 | | |
| | 12.00 | 0,024 | | |
| | 14.00 | 0,023 | | |
| | 16.00 | 0,023 | | |

| | **Δ l / l [mm/m]** | **Δ l /ΔT [µm/°C]** |
|---|---|---|
| x-direction | 0,456 | 12,00 |
| y-direction | 0,465 | 11,92 |
| z-direction | 0,459 | 12,08 |

| **Thermal Dilatation** | | | |
|---|---|---|---|
| **Sample** | W3, Jinchuanwan Grotto | | |
| **Comment** | stone cube untreated | | |
| **Direction** | x | y | z |
| **Date** | 16.2.2009 | 23.2.2009 | 25.2.2009 |
| **Temperature** | 24°C | 23°C | 24°C |
| **Relative humidity** | 28 % | 33 % | 32 % |
| **Start temperature** | 62°C | 62°C | 62°C |
| **Length [mm]** | 50,47 | 50,99 | 49,36 |
| **$m_0$ [g]** | 323,385 | 323,372 | 323,200 |
| **$m_1$ [g]** | 323,502 | 323,509 | 333,439 |
| **Dial gauge** | 3 | 3 | 3 |

| **Date** | **Time** | **Δ l [mm]** | **Δ l / l [mm/m]** | **Comment** |
|---|---|---|---|---|
| 26.2.2009 | 8.15 | 0,000 | 0,456 | x-direction |
| | 8.25 | 0,013 | | |
| | 9.00 | 0,023 | | |
| | 10.00 | 0,024 | | |
| | 12.00 | 0,024 | | |
| | 14.00 | 0,024 | | |
| | 16.00 | 0,023 | | |
| 23.2.2009 | 7.32 | 0,000 | 0,451 | y-direction |
| | 7.45 | 0,014 | | |
| | 8.02 | 0,023 | | |
| | 8.30 | 0,023 | | |
| | 9.30 | 0,023 | | |
| | 11.30 | 0,024 | | |
| | 13.30 | 0,024 | | |
| | 16.00 | 0,023 | | |
| 25.2.2009 | 7.56 | 0,000 | 0,466 | z-direction |
| | 8.05 | 0,006 | | |
| | 8.25 | 0,021 | | |
| | 9.00 | 0,024 | | |
| | 10.00 | 0,024 | | |
| | 12.00 | 0,024 | | |
| | 14.00 | 0,023 | | |
| | 16.00 | 0,023 | | |

| | **Δ l / l [mm/m]** | **Δ l /ΔT [µm/°C]** |
|---|---|---|
| x-direction | 0,456 | 12,00 |
| y-direction | 0,451 | 11,56 |
| z-direction | 0,466 | 12,26 |

| **Thermal Dilatation** | | | |
|---|---|---|---|
| **Sample** | W4, Jinchuanwan Grotto | | |
| **Comment** | stone cube untreated | | |
| **Direction** | x | y | z |
| **Date** | 27.2.2009 | 23.2.2009 | 25.2.2009 |
| **Temperature** | 24°C | 23°C | 24°C |
| **Relative humidity** | 32 % | 33 % | 32 % |
| **Start temperature** | 62°C | 62°C | 62°C |
| **Length [mm]** | 50,84 | 51,70 | 49,39 |
| **$m_0$ [g]** | 330,074 | 330,600 | 329,880 |
| **$m_1$ [g]** | 330,187 | 330,191 | 330,114 |
| **Dial gauge** | 1 | 4 | 4 |

| Date | Time | Δ l [mm] | Δ l / l [mm/m] | Comment |
|---|---|---|---|---|
| 27.2.2009 | 8.10 | 0,000 | 0,452 | x-direction |
| | 8.30 | 0,009 | | |
| | 8.50 | 0,021 | | |
| | 9.50 | 0,023 | | |
| | 11.50 | 0,023 | | |
| | 14.50 | 0,023 | | |
| | 16.00 | 0,023 | | |
| 23.2.2009 | 7.32 | 0,000 | 0,445 | y-direction |
| | 7.45 | 0,014 | | |
| | 8.02 | 0,022 | | |
| | 8.30 | 0,024 | | |
| | 9.30 | 0,024 | | |
| | 11.30 | 0,024 | | |
| | 13.30 | 0,023 | | |
| | 16.00 | 0,023 | | |
| 25.2.2009 | 7.56 | 0,000 | 0,445 | z-direction |
| | 8.05 | 0,008 | | |
| | 8.25 | 0,020 | | |
| | 9.00 | 0,022 | | |
| | 10.00 | 0,022 | | |
| | 12.00 | 0,022 | | |
| | 14.00 | 0,022 | | |
| | 16.00 | 0,022 | | |

| | Δ l / l [mm/m] | Δ l /ΔT [µm/°C] |
|---|---|---|
| x-direction | 0,452 | 11,89 |
| y-direction | 0,445 | 11,41 |
| z-direction | 0,445 | 11,71 |

| **Thermal Dilatation** | | | |
|---|---|---|---|
| **Sample** | W5, Jinchuanwan Grotto | | |
| **Comment** | stone cube untreated | | |
| **Direction** | x | y | z |
| **Date** | 26.2.2009 | 23.2.2009 | 25.2.2009 |
| **Temperature** | 24°C | 23°C | 24°C |
| **Relative humidity** | 32 % | 33 % | 32 % |
| **Start temperature** | 62°C | 62°C | 62°C |
| **Length [mm]** | 50,38 | 49,68 | 49,89 |
| **$m_0$ [g]** | 316,706 | 316,701 | 316,546 |
| **$m_1$ [g]** | 316,820 | 316,825 | 316,771 |
| **Dial gauge** | 2 | 5 | 5 |

| Date | Time | Δ l [mm] | Δ l / l [mm/m] | Comment |
|---|---|---|---|---|
| 26.2.2009 | 8.15 | 0,000 | 0,476 | x-direction |
| | 8.25 | 0,011 | | |
| | 9.00 | 0,024 | | |
| | 10.00 | 0,025 | | |
| | 14.00 | 0,025 | | |
| | 16.00 | 0,024 | | |
| 23.2.2009 | 7.32 | 0,000 | 0,483 | y-direction |
| | 7.45 | 0,015 | | |
| | 8.02 | 0,023 | | |
| | 8.30 | 0,025 | | |
| | 9.30 | 0,025 | | |
| | 11.30 | 0,025 | | |
| | 13.30 | 0,024 | | |
| | 16.00 | 0,024 | | |
| 25.2.2009 | 7.56 | 0,000 | 0,461 | z-direction |
| | 8.05 | 0,006 | | |
| | 8.25 | 0,020 | | |
| | 9.00 | 0,023 | | |
| | 10.00 | 0,023 | | |
| | 12.00 | 0,023 | | |
| | 14.00 | 0,023 | | |
| | 16.00 | 0,023 | | |

| | Δ l / l [mm/m] | Δ l /ΔT [µm/°C] |
|---|---|---|
| x-direction | 0,476 | 12,53 |
| y-direction | 0,483 | 12,38 |
| z-direction | 0,461 | 12,13 |

| **Thermal Dilatation** | | | |
|---|---|---|---|
| **Sample** | W6, Jinchuanwan Grotto | | |
| **Comment** | stone cube untreated | | |
| **Direction** | x | y | z |
| **Date** | 27.2.2009 | 23.2.2009 | 25.2.2009 |
| **Temperature** | 24°C | 23°C | 24°C |
| **Relative humidity** | 32 % | 33 % | 32 % |
| **Start temperature** | 62°C | 62°C | 62°C |
| **Length [mm]** | 50,12 | 51,44 | 49,89 |
| **$m_0$ [g]** | 329,019 | 329,16 | 328,845 |
| **$m_1$ [g]** | 329,141 | 329,148 | 323,089 |
| **Dial gauge** | 2 | 6 | 6 |

| Date | Time | Δ l [mm] | Δ l / l [mm/m] | Comment |
|---|---|---|---|---|
| 27.2.2009 | 8.10 | 0,000 | 0,479 | x-direction |
| | 8.30 | 0,010 | | |
| | 8.50 | 0,023 | | |
| | 9.50 | 0,025 | | |
| | 11.50 | 0,025 | | |
| | 14.50 | 0,025 | | |
| | 16.00 | 0,024 | | |
| 23.2.2009 | 7.33 | 0,000 | 0,467 | y-direction |
| | 7.45 | 0,014 | | |
| | 8.02 | 0,022 | | |
| | 8.30 | 0,025 | | |
| | 9.30 | 0,025 | | |
| | 11.30 | 0,025 | | |
| | 13.30 | 0,024 | | |
| | 16.00 | 0,024 | | |
| 25.2.2009 | 7.55 | 0,000 | 0,481 | z-direction |
| | 8.05 | 0,007 | | |
| | 8.25 | 0,021 | | |
| | 9.00 | 0,025 | | |
| | 10.00 | 0,025 | | |
| | 12.00 | 0,025 | | |
| | 14.00 | 0,025 | | |
| | 16.00 | 0,024 | | |

| | Δ l / l [mm/m] | Δ l /ΔT [µm/°C] |
|---|---|---|
| x-direction | 0,479 | 12,61 |
| y-direction | 0,467 | 11,97 |
| z-direction | 0,481 | 12,66 |

| **Thermal Dilatation** | | | |
|---|---|---|---|
| **Sample** | W7, Jinchuanwan Grotto | | |
| **Comment** | stone cube, soaked KSE OH | | |
| **Direction** | x | y | z |
| **Date** | 16.2.2009 | 27.2.2009 | 26.2.2009 |
| **Temperature** | 24°C | 24°C | 24°C |
| **Relative humidity** | 28 % | 32 % | 32 % |
| **Start temperature** | 62°C | 62°C | 62°C |
| **Length [mm]** | 50,03 | 52,70 | 50,44 |
| **$m_0$ [g]** | 336,518 | 336,126 | 336,069 |
| **$m_1$ [g]** | 336,642 | 336,259 | 336,291 |
| **Dial gauge** | 1 | 3 | 3 |

| Date | Time | Δ l [mm] | Δ l / l [mm/m] | Comment |
|---|---|---|---|---|
| 17.2.2009 | 8.17 | 0,000 | 0,440 | x-direction |
| | 8.30 | 0,013 | | |
| | 8.50 | 0,021 | | |
| | 9.20 | 0,022 | | |
| | 10.20 | 0,023 | | |
| | 12.20 | 0,023 | | |
| | 16.20 | 0,022 | | |
| 27.2.2009 | 8.10 | 0,000 | 0,436 | y-direction |
| | 8.30 | 0,009 | | |
| | 8.50 | 0,022 | | |
| | 9.50 | 0,024 | | |
| | 11.50 | 0,024 | | |
| | 14.50 | 0,023 | | |
| | 16.00 | 0,023 | | |
| 26.2.2009 | 8.15 | 0,000 | 0,476 | z-direction |
| | 8.25 | 0,011 | | |
| | 9.00 | 0,024 | | |
| | 10.00 | 0,025 | | |
| | 12.00 | 0,025 | | |
| | 14.00 | 0,025 | | |
| | 16.00 | 0,024 | | |

| | Δ l / l [mm/m] | Δ l /ΔT [µm/°C] |
|---|---|---|
| x-direction | 0,440 | 11,58 |
| y-direction | 0,436 | 11,47 |
| z-direction | 0,476 | 12,53 |

| **Thermal Dilatation** | | | |
|---|---|---|---|
| **Sample** | W8, Jinchuanwan Grotto | | |
| **Comment** | stone cube, KSE OH 1 min/side | | |
| **Direction** | x | y | z |
| **Date** | 16.2.2009 | 26.2.2009 | 27.2.2009 |
| **Temperature** | 24°C | 24°C | 24°C |
| **Relative humidity** | 28 % | 32 % | 32 % |
| **Start temperature** | 62°C | 62°C | 62°C |
| **Length [mm]** | 50,37 | 49,64 | 50,04 |
| **$m_0$ [g]** | 321,134 | 320,765 | 320,725 |
| **$m_1$ [g]** | 321,260 | 320,902 | 320,943 |
| **Dial gauge** | 2 | 4 | Aluständer |

| Date | Time | Δ l [mm] | Δ l / l [mm/m] | Comment |
|---|---|---|---|---|
| 17.2.2009 | 8.17 | 0,000 | 0,437 | x-direction |
| | 8.30 | 0,016 | | |
| | 8.50 | 0,019 | | |
| | 9.20 | 0,022 | | |
| | 10.20 | 0,023 | | |
| | 12.20 | 0,022 | | |
| | 16.20 | 0,022 | | |
| 26.2.2009 | 8.15 | 0,000 | 0,463 | y-direction |
| | 8.25 | 0,014 | | |
| | 9.00 | 0,023 | | |
| | 10.00 | 0,023 | | |
| | 12.00 | 0,023 | | |
| | 14.00 | 0,023 | | |
| | 16.00 | 0,023 | | |
| 27.2.2009 | 8.10 | 0,000 | 0,500 | z-direction |
| | 8.30 | 0,016 | | |
| | 8.50 | 0,024 | | |
| | 9.50 | 0,025 | | |
| | 11.50 | 0,025 | | |
| | 14.50 | 0,025 | | |
| | 16.00 | 0,025 | | |

| | Δ l / l [mm/m] | Δ l /ΔT [μm/°C] |
|---|---|---|
| x-direction | 0,437 | 11,50 |
| y-direction | 0,463 | 12,18 |
| z-direction | 0,500 | 13,16 |

| **Thermal Dilatation** | | | |
|---|---|---|---|
| **Sample** | W9, Jinchuanwan Grotto | | |
| **Comment** | stone cube, soaked KSE 100 | | |
| **Direction** | x | y | z |
| **Date** | 16.2.2009 | 23.2.2009 | 26.2.2009 |
| **Temperature** | 24°C | 24°C | 24°C |
| **Relative humidity** | 28 % | 33 % | 32 % |
| **Start temperature** | 62°C | 62°C | 62°C |
| **Length [mm]** | 50,26 | 51,50 | 49,76 |
| **$m_0$ [g]** | 328,395 | 327,977 | 327,930 |
| **$m_1$ [g]** | 328,507 | 328,108 | 328,141 |
| **Dial gauge** | 3 | Alusländer | Alusländer |

| Date | Time | Δ l [mm] | Δ l / l [mm/m] | Comment |
|---|---|---|---|---|
| 17.2.2009 | 8.19 | 0,000 | 0,438 | x-direction |
| | 8.30 | 0,012 | | |
| | 8.50 | 0,020 | | |
| | 9.20 | 0,022 | | |
| | 10.20 | 0,022 | | |
| | 12.20 | 0,022 | | |
| | 16.20 | 0,022 | | |
| 23.2.2009 | 7.54 | 0,000 | 0,427 | y-direction |
| | 8.03 | 0,016 | | |
| | 8.20 | 0,023 | | |
| | 8.50 | 0,023 | | |
| | 9.50 | 0,022 | | |
| | 11.50 | 0,022 | | |
| | 15.50 | 0,022 | | |
| 26.2.2009 | 8.15 | 0,000 | 0,482 | z-direction |
| | 8.25 | 0,008 | | |
| | 9.00 | 0,024 | | |
| | 10.00 | 0,025 | | |
| | 12.00 | 0,025 | | |
| | 14.00 | 0,024 | | |
| | 16.00 | 0,024 | | |

| | Δ l / l [mm/m] | Δ l /ΔT [µm/°C] |
|---|---|---|
| x-direction | 0,438 | 11,53 |
| y-direction | 0,427 | 11,24 |
| z-direction | 0,482 | 12,68 |

| **Thermal Dilatation** | | | |
|---|---|---|---|
| **Sample** | W10, Jinchuanwan Grotto | | |
| **Comment** | stone cube, KSE 100 1 min/side | | |
| **Direction** | x | y | z |
| **Date** | 16.2.2009 | 27.2.2009 | 25.2.2009 |
| **Temperature** | 24°C | 24°C | 24°C |
| **Relative humidity** | 28 % | 32 % | 32 % |
| **Start temperature** | 62°C | 62°C | 62°C |
| **Length [mm]** | 49,83 | 50,65 | 49,90 |
| **$m_0$ [g]** | 321,574 | 321,204 | 321,168 |
| **$m_1$ [g]** | 321,692 | 321,337 | 321,377 |
| **Dial gauge** | 4 | Alusländer | Alusländer |

| **Date** | **Time** | **Δ l [mm]** | **Δ l / l [mm/m]** | **Comment** |
|---|---|---|---|---|
| 17.2.2009 | 8.17 | 0,000 | 0,442 | x-direction |
| | 8.30 | 0,008 | | |
| | 8.50 | 0,020 | | |
| | 9.20 | 0,022 | | |
| | 10.20 | 0,022 | | |
| | 12.20 | 0,022 | | |
| | 16.20 | 0,022 | | |
| 27.2.2009 | 8.10 | 0,000 | 0,474 | y-direction |
| | 8.30 | 0,018 | | |
| | 8.50 | 0,022 | | |
| | 9.50 | 0,024 | | |
| | 11.50 | 0,024 | | |
| | 14.50 | 0,024 | | |
| | 16.00 | 0,024 | | |
| 25.2.2009 | 8.14 | 0,000 | 0,441 | z-direction |
| | 8.25 | 0,015 | | |
| | 8.40 | 0,020 | | |
| | 9.10 | 0,023 | | |
| | 10.10 | 0,023 | | |
| | 12.10 | 0,023 | | |
| | 14.00 | 0,022 | | |
| | 16.00 | 0,022 | | |

| | **Δ l / l [mm/m]** | **Δ l /ΔT [µm/°C]** |
|---|---|---|
| x-direction | 0,442 | 11,63 |
| y-direction | 0,474 | 12,47 |
| z-direction | 0,441 | 11,61 |

| **Thermal Dilatation** | | | |
|---|---|---|---|
| **Sample** | W11, Jinchuanwan Grotto | | |
| **Comment** | stone cube, KSE 300 1 min/side | | |
| **Direction** | x | y | z |
| **Date** | 16.2.2009 | 26.2.2009 | 26.2.2009 |
| **Temperature** | 24°C | 24°C | 24°C |
| **Relative humidity** | 28 % | 32 % | 32 % |
| **Start temperature** | 62°C | 62°C | 62°C |
| **Length [mm]** | 50,75 | 51,62 | 50,21 |
| **$m_0$ [g]** | 337,973 | 337,563 | 337,523 |
| **$m_1$ [g]** | 338,101 | 337,702 | 337,741 |
| **Dial gauge** | 5 | Alusländer | 6 |

| Date | Time | Δ l [mm] | Δ l / l [mm/m] | Comment |
|---|---|---|---|---|
| 17.2.2009 | 8.20 | 0,000 | 0,434 | x-direction |
| | 8.30 | 0,012 | | |
| | 8.50 | 0,020 | | |
| | 9.20 | 0,022 | | |
| | 10.20 | 0,023 | | |
| | 12.20 | 0,022 | | |
| | 16.20 | 0,022 | | |
| 26.2.2009 | 8.15 | 0,000 | 0,446 | y-direction |
| | 8.25 | 0,011 | | |
| | 9.00 | 0,023 | | |
| | 10.00 | 0,024 | | |
| | 12.00 | 0,024 | | |
| | 14.00 | 0,023 | | |
| | 16.00 | 0,023 | | |
| 25.2.2009 | 8.15 | 0,000 | 0,438 | z-direction |
| | 8.25 | 0,015 | | |
| | 8.40 | 0,021 | | |
| | 9.10 | 0,022 | | |
| | 10.10 | 0,022 | | |
| | 12.10 | 0,022 | | |
| | 14.00 | 0,022 | | |
| | 16.00 | 0,022 | | |

| | Δ l / l [mm/m] | Δ l /ΔT [µm/°C] |
|---|---|---|
| x-direction | 0,434 | 11,42 |
| y-direction | 0,446 | 11,74 |
| z-direction | 0,438 | 11,53 |

| **Thermal Dilatation** | | | |
|---|---|---|---|
| **Sample** | W12, Jinchuanwan Grotto | | |
| **Comment** | stone cube, soaked KSE 300 | | |
| **Direction** | x | y | z |
| **Date** | 16.2.2009 | 23.2.2009 | 27.2.2009 |
| **Temperature** | 24°C | 24°C | 24°C |
| **Relative humidity** | 28 % | 33 % | 32 % |
| **Start temperature** | 62°C | 62°C | 62°C |
| **Length [mm]** | 50,88 | 50,43 | 50,55 |
| **$m_0$ [g]** | 333,397 | 323,967 | 332,992 |
| **$m_1$ [g]** | 333,511 | 333,106 | 333,132 |
| **Dial gauge** | 6 | Aluständer | 5 |

| Date | Time | Δ l [mm] | Δ l / l [mm/m] | Comment |
|---|---|---|---|---|
| 17.2.2009 | 8.20 | 0,000 | 0,413 | x-direction |
| | 8.30 | 0,012 | | |
| | 8.50 | 0,018 | | |
| | 9.20 | 0,021 | | |
| | 10.20 | 0,022 | | |
| | 12.20 | 0,021 | | |
| | 16.20 | 0,021 | | |
| 23.2.2009 | 7.58 | 0,000 | 0,416 | y-direction |
| | 8.03 | 0,006 | | |
| | 8.20 | 0,018 | | |
| | 8.50 | 0,019 | | |
| | 9.50 | 0,019 | | |
| | 11.50 | 0,021 | | |
| | 15.50 | 0,021 | | |
| 27.2.2009 | 8.10 | 0,000 | 0,455 | z-direction |
| | 8.30 | 0,009 | | |
| | 8.50 | 0,021 | | |
| | 9.50 | 0,023 | | |
| | 11.50 | 0,023 | | |
| | 14.50 | 0,023 | | |
| | 16.00 | 0,023 | | |

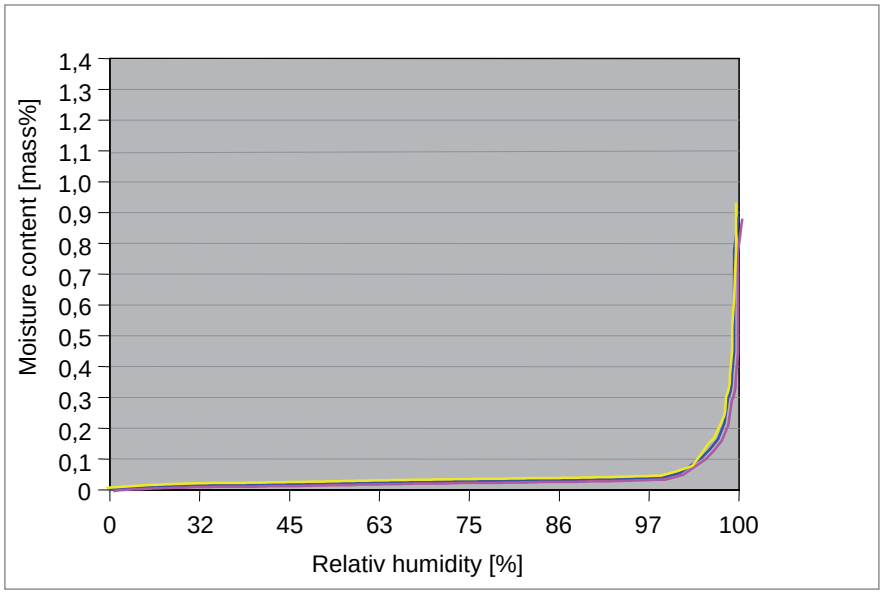
| | Δ l / l [mm/m] | Δ l /ΔT [µm/°C] |
|---|---|---|
| x-direction | 0,413 | 10,87 |
| y-direction | 0,416 | 10,95 |
| z-direction | 0,455 | 11,97 |

# Sorptionsisotherme/Isothermal Line of Sorption

Isothermal Line of Sorption W1, W2, W3 (untreated samples)

| Date | W 1-1 | W 1-2 | W 1-3 | Ø W 1 | W 2-1 | W 2-2 | W 2-3 | Ø W 2 | W 3-1 | W 3-2 | W 3-3 | Ø W 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0% RH | | | | | | | | | | | | |
| 25.03.09 | 21,782 | 21,221 | 21,489 | 21,488 | 20,614 | 22,230 | 21,713 | 21,619 | 21,758 | 21,659 | 21,428 | 21,616 |
| 32% RH | | | | | | | | | | | | |
| 25.03.09 08:45 | 21,783 | 21,221 | 21,489 | 21,498 | 20,614 | 22,230 | 21,713 | 21,619 | 21,758 | 21,659 | 21,428 | 21,616 |
| 26.03.09 16:10 | 21,861 | 21,285 | 21,564 | 21,687 | 20,690 | 22,297 | 21,778 | 21,688 | 21,841 | 21,728 | 21,497 | 21,689 |
| 27.03.09 14:45 | 21,876 | 21,304 | 21,572 | 21,684 | 20,700 | 22,315 | 21,797 | 21,804 | 21,852 | 21,746 | 21,513 | 21,704 |
| 30.03.09 09:25 | 21,879 | 21,311 | 21,580 | 21,690 | 20,701 | 22,322 | 21,806 | 21,810 | 21,855 | 21,751 | 21,520 | 21,709 |
| water absorption | 0,096 | 0,090 | 0,091 | 0,092 | 0,087 | 0,092 | 0,093 | 0,091 | 0,097 | 0,092 | 0,092 | 0,094 |
| water absorption % | 0,021 | 0,018 | 0,020 | 0,020 | 0,018 | 0,020 | 0,020 | 0,020 | 0,021 | 0,020 | 0,020 | 0,020 |
| 45% RH | | | | | | | | | | | | |
| 30.03.09 09:25 | 21,879 | 21,311 | 21,580 | 21,690 | 20,701 | 22,322 | 21,806 | 21,810 | 21,855 | 21,751 | 21,520 | 21,709 |
| 31.03.09 09:10 | 21,893 | 21,327 | 21,599 | 21,808 | 20,716 | 22,339 | 21,823 | 21,828 | 21,872 | 21,767 | 21,536 | 21,725 |
| 01.04.09 08:30 | 21,897 | 21,331 | 21,603 | 21,810 | 20,718 | 22,342 | 21,831 | 21,830 | 21,875 | 21,772 | 21,542 | 21,730 |
| 02.04.09 09:20 | 21,896 | 21,330 | 21,603 | 21,810 | 20,717 | 22,343 | 21,830 | 21,830 | 21,873 | 21,772 | 21,541 | 21,729 |
| water absorption | 0,113 | 0,109 | 0,114 | 0,112 | 0,103 | 0,113 | 0,117 | 0,111 | 0,115 | 0,113 | 0,113 | 0,114 |
| water absorption % | 0,025 | 0,023 | 0,024 | 0,024 | 0,021 | 0,026 | 0,026 | 0,024 | 0,026 | 0,024 | 0,024 | 0,025 |
| 63% RH | | | | | | | | | | | | |
| 02.04.09 09:20 | 21,896 | 21,330 | 21,603 | 21,810 | 20,717 | 22,343 | 21,830 | 21,830 | 21,873 | 21,772 | 21,541 | 21,729 |
| 06.04.09 07:30 | 21,938 | 21,385 | 21,663 | 21,862 | 20,757 | 22,399 | 21,890 | 21,882 | 21,917 | 21,826 | 21,597 | 21,780 |
| 07.04.09 07:45 | 21,940 | 21,386 | 21,663 | 21,863 | 20,759 | 22,400 | 21,890 | 21,883 | 21,916 | 21,826 | 21,597 | 21,780 |
| water absorption | 0,157 | 0,165 | 0,174 | 0,166 | 0,145 | 0,170 | 0,177 | 0,164 | 0,158 | 0,167 | 0,169 | 0,165 |
| water absorption % | 0,034 | 0,036 | 0,037 | 0,038 | 0,030 | 0,038 | 0,038 | 0,035 | 0,034 | 0,036 | 0,036 | 0,036 |
| 75% RH | | | | | | | | | | | | |
| 07.04.09 07:45 | 21,940 | 21,386 | 21,663 | 21,863 | 20,759 | 22,400 | 21,890 | 21,883 | 21,916 | 21,826 | 21,597 | 21,780 |
| 09.04.09 07:30 | 21,961 | 21,412 | 21,695 | 21,888 | 20,777 | 22,425 | 21,921 | 21,708 | 21,938 | 21,846 | 21,625 | 21,804 |
| 14.04.09 07:45 | 21,966 | 21,418 | 21,700 | 21,886 | 20,780 | 22,432 | 21,928 | 21,713 | 21,942 | 21,856 | 21,631 | 21,810 |
| 15.04.09 15:15 | 21,967 | 21,421 | 21,702 | 21,887 | 20,781 | 22,432 | 21,930 | 21,714 | 21,942 | 21,857 | 21,631 | 21,810 |
| water absorption | 0,184 | 0,200 | 0,213 | 0,199 | 0,167 | 0,202 | 0,217 | 0,195 | 0,184 | 0,198 | 0,203 | 0,195 |
| water absorption % | 0,040 | 0,043 | 0,046 | 0,043 | 0,036 | 0,046 | 0,048 | 0,042 | 0,040 | 0,043 | 0,044 | 0,042 |
| 86% RH | | | | | | | | | | | | |
| 15.04.09 15:15 | 21,967 | 21,421 | 21,702 | 21,887 | 20,781 | 22,432 | 21,930 | 21,714 | 21,942 | 21,857 | 21,631 | 21,810 |
| 20.04.09 09:15 | 21,991 | 21,452 | 21,748 | 21,730 | 20,308 | 22,464 | 21,971 | 21,681 | 21,964 | 21,889 | 21,670 | 21,841 |
| 21.04.09 08:30 | 21,988 | 21,452 | 21,744 | 21,728 | 20,800 | 22,464 | 21,971 | 21,746 | 21,964 | 21,889 | 21,670 | 21,841 |
| water absorption | 0,205 | 0,231 | 0,255 | 0,230 | 0,186 | 0,234 | 0,258 | 0,226 | 0,206 | 0,230 | 0,242 | 0,226 |
| water absorption % | 0,046 | 0,049 | 0,056 | 0,050 | 0,038 | 0,052 | 0,058 | 0,049 | 0,046 | 0,050 | 0,052 | 0,049 |
| 97% RH | | | | | | | | | | | | |
| 21.04.09 08:30 | 21,988 | 21,452 | 21,744 | 21,728 | 20,800 | 22,464 | 21,971 | 21,746 | 21,964 | 21,889 | 21,670 | 21,841 |
| 24.04.09 13:50 | 22,059 | 21,462 | 21,817 | 21,778 | 20,873 | 22,544 | 22,015 | 21,812 | 22,031 | 21,977 | 21,733 | 21,914 |
| 28.04.09 09:00 | 22,112 | 21,534 | 21,787 | 21,811 | 20,908 | 22,565 | 22,018 | 21,830 | 22,101 | 21,987 | 21,743 | 21,944 |
| 29.04.09 07:00 | 22,111 | 21,535 | 21,786 | 21,811 | 20,909 | 22,551 | 22,016 | 21,826 | 22,098 | 21,986 | 21,741 | 21,942 |
| water absorption | 0,328 | 0,314 | 0,297 | 0,313 | 0,295 | 0,321 | 0,303 | 0,306 | 0,340 | 0,327 | 0,313 | 0,327 |
| water absorption % | 0,071 | 0,067 | 0,064 | 0,067 | 0,061 | 0,071 | 0,066 | 0,068 | 0,074 | 0,071 | 0,067 | 0,071 |

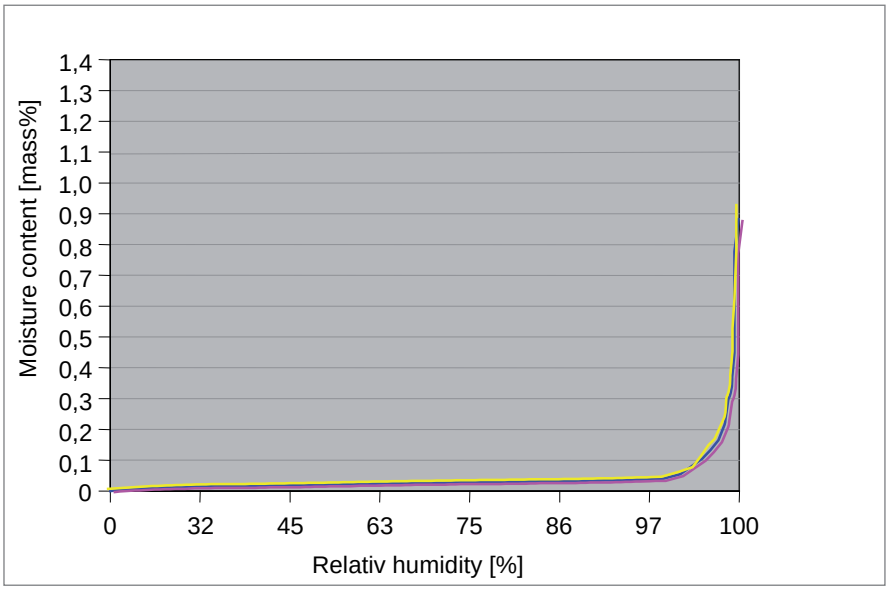
| Relative Humidity [%] | Water Uptake [mass%] | | |
|---|---|---|---|
| | W1 | W2 | W3 |
| 0 | 0,000 | 0,000 | 0,000 |
| 32 | 0,020 | 0,020 | 0,020 |
| 45 | 0,024 | 0,024 | 0,025 |
| 63 | 0,036 | 0,035 | 0,036 |
| 75 | 0,043 | 0,042 | 0,042 |
| 86 | 0,050 | 0,049 | 0,049 |
| 97 | 0,067 | 0,066 | 0,071 |
| immersed in water for 48 hours | 1,09 | 1,16 | 1,34 |



Isothermal Line of Sorption W4, W5, W6 (untreated samples)

| Messzeitpunkt | W 4-1 | W 4-2 | W 4-3 | Ø W 4 | W 5-1 | W 5-2 | W 5-3 | Ø W 5 | W 6-1 | W 6-2 | W 6-3 | Ø W 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0% RH | | | | | | | | | | | | |
| 25.03.09 | 17,630 | 21,661 | 20,834 | 20,042 | 17,503 | 34,100 | 21,901 | 21,168 | 21,148 | 21,544 | 21,016 | 21,288 |
| 32% RH | | | | | | | | | | | | |
| 27.03.09 14:50 | 17,635 | 21,654 | 20,840 | 20,048 | 17,510 | 34,106 | 21,906 | 21,174 | 21,153 | 21,549 | 21,021 | 21,274 |
| 30.03.09 09:30 | 17,708 | 21,751 | 20,922 | 20,127 | 17,579 | 34,194 | 21,986 | 21,263 | 21,238 | 21,736 | 21,099 | 21,368 |
| 31.03.09 09:15 | 17,707 | 21,752 | 20,921 | 20,127 | 17,576 | 34,194 | 21,986 | 21,262 | 21,237 | 21,735 | 21,100 | 21,367 |
| 01.04.09 09:55 | 17,708 | 21,752 | 20,923 | 20,127 | 17,576 | 34,194 | 21,986 | 21,262 | 21,237 | 21,735 | 21,100 | 21,367 |
| water absorption | 0,072 | 0,088 | 0,081 | 0,080 | 0,066 | 0,088 | 0,080 | 0,078 | 0,084 | 0,086 | 0,079 | 0,083 |
| water absorption % | 0,013 | 0,016 | 0,017 | 0,016 | 0,012 | 0,021 | 0,018 | 0,017 | 0,018 | 0,018 | 0,017 | 0,018 |
| 45% RH | | | | | | | | | | | | |
| 01.04.09 09:55 | 17,708 | 21,752 | 20,923 | 20,128 | 17,576 | 34,194 | 21,986 | 21,262 | 21,237 | 21,735 | 21,100 | 21,367 |
| 02.04.09 09:20 | 17,720 | 21,766 | 20,939 | 20,142 | 17,589 | 34,212 | 22,004 | 21,288 | 21,251 | 21,750 | 21,113 | 21,371 |
| 06.04.09 07:50 | 17,725 | 21,778 | 20,951 | 20,151 | 17,593 | 34,224 | 22,018 | 21,278 | 21,258 | 21,757 | 21,120 | 21,378 |
| 07.04.09 07:50 | 17,724 | 21,778 | 20,952 | 20,151 | 17,591 | 34,225 | 22,021 | 21,279 | 21,257 | 21,756 | 21,120 | 21,378 |
| water absorption | 0,088 | 0,114 | 0,110 | 0,104 | 0,081 | 0,119 | 0,115 | 0,105 | 0,104 | 0,107 | 0,099 | 0,103 |
| water absorption % | 0,016 | 0,026 | 0,023 | 0,021 | 0,014 | 0,028 | 0,026 | 0,022 | 0,022 | 0,023 | 0,021 | 0,022 |
| 63% RH | | | | | | | | | | | | |
| 07.04.09 07:50 | 17,724 | 21,778 | 20,952 | 20,151 | 17,591 | 34,225 | 22,021 | 21,279 | 21,257 | 21,756 | 21,120 | 21,378 |
| 09.04.09 07:35 | 17,754 | 21,819 | 20,995 | 20,190 | 17,616 | 34,267 | 22,063 | 21,315 | 21,288 | 21,791 | 21,155 | 21,411 |
| 14.04.09 07:40 | 17,756 | 21,825 | 21,003 | 20,196 | 17,619 | 34,273 | 22,071 | 21,321 | 21,290 | 21,794 | 21,158 | 21,414 |
| 16.04.09 15:20 | 17,756 | 21,825 | 21,003 | 20,196 | 17,619 | 34,272 | 22,070 | 21,320 | 21,290 | 21,795 | 21,158 | 21,414 |
| water absorption | 0,120 | 0,161 | 0,161 | 0,147 | 0,109 | 0,166 | 0,164 | 0,146 | 0,137 | 0,146 | 0,137 | 0,140 |
| water absorption % | 0,021 | 0,036 | 0,034 | 0,030 | 0,019 | 0,040 | 0,038 | 0,031 | 0,029 | 0,032 | 0,029 | 0,030 |
| 75% RH | | | | | | | | | | | | |
| 16.04.09 15:20 | 17,756 | 21,825 | 21,003 | 20,196 | 17,619 | 34,272 | 22,070 | 21,320 | 21,290 | 21,795 | 21,158 | 21,414 |
| 20.04.09 09:20 | 17,777 | 21,854 | 21,035 | 20,222 | 17,636 | 34,301 | 22,105 | 21,347 | 21,312 | 21,820 | 21,184 | 21,498 |
| 21.04.09 08:45 | 17,775 | 21,853 | 21,035 | 20,221 | 17,636 | 34,300 | 22,104 | 21,347 | 21,310 | 21,819 | 21,181 | 21,437 |
| water absorption | 0,139 | 0,189 | 0,193 | 0,174 | 0,126 | 0,194 | 0,198 | 0,173 | 0,157 | 0,170 | 0,160 | 0,162 |
| water absorption % | 0,026 | 0,041 | 0,040 | 0,036 | 0,022 | 0,047 | 0,043 | 0,037 | 0,033 | 0,037 | 0,034 | 0,036 |
| 86% RH | | | | | | | | | | | | |
| 21.04.09 08:45 | 17,775 | 21,853 | 21,035 | 20,221 | 17,636 | 34,300 | 22,104 | 21,347 | 21,310 | 21,819 | 21,181 | 21,437 |
| 24.04.09 13:45 | 17,793 | 21,883 | 21,077 | 20,251 | 17,651 | 34,330 | 22,142 | 21,374 | 21,325 | 21,836 | 21,201 | 21,466 |
| 28.04.09 09:10 | 17,795 | 21,888 | 21,087 | 20,257 | 17,655 | 34,337 | 22,155 | 21,382 | 21,334 | 21,841 | 21,209 | 21,480 |
| 29.04.09 06:40 | 17,797 | 21,888 | 21,082 | 20,258 | 17,654 | 34,336 | 22,154 | 21,381 | 21,334 | 21,840 | 21,203 | 21,469 |
| water absorption | 0,151 | 0,224 | 0,240 | 0,208 | 0,144 | 0,230 | 0,248 | 0,207 | 0,181 | 0,191 | 0,182 | 0,185 |
| water absorption % | 0,028 | 0,049 | 0,050 | 0,042 | 0,026 | 0,056 | 0,064 | 0,044 | 0,038 | 0,041 | 0,038 | 0,038 |
| 97% RH | | | | | | | | | | | | |
| 29.04.09 06:40 | 17,797 | 21,888 | 21,082 | 20,258 | 17,654 | 34,336 | 22,154 | 21,381 | 21,334 | 21,840 | 21,203 | 21,469 |
| 05.05.09 08:00 | 17,851 | 21,995 | 21,134 | 20,327 | 17,704 | 34,440 | 22,193 | 21,448 | 21,450 | 21,895 | 21,256 | 21,534 |
| 06.05.09 12:30 | 17,860 | 21,994 | 21,130 | 20,326 | 17,705 | 34,438 | 22,190 | 21,444 | 21,450 | 21,899 | 21,256 | 21,535 |
| water absorption | 0,214 | 0,330 | 0,288 | 0,277 | 0,195 | 0,332 | 0,284 | 0,270 | 0,297 | 0,250 | 0,235 | 0,261 |
| water absorption % | 0,038 | 0,071 | 0,060 | 0,056 | 0,034 | 0,080 | 0,062 | 0,067 | 0,063 | 0,054 | 0,048 | 0,055 |

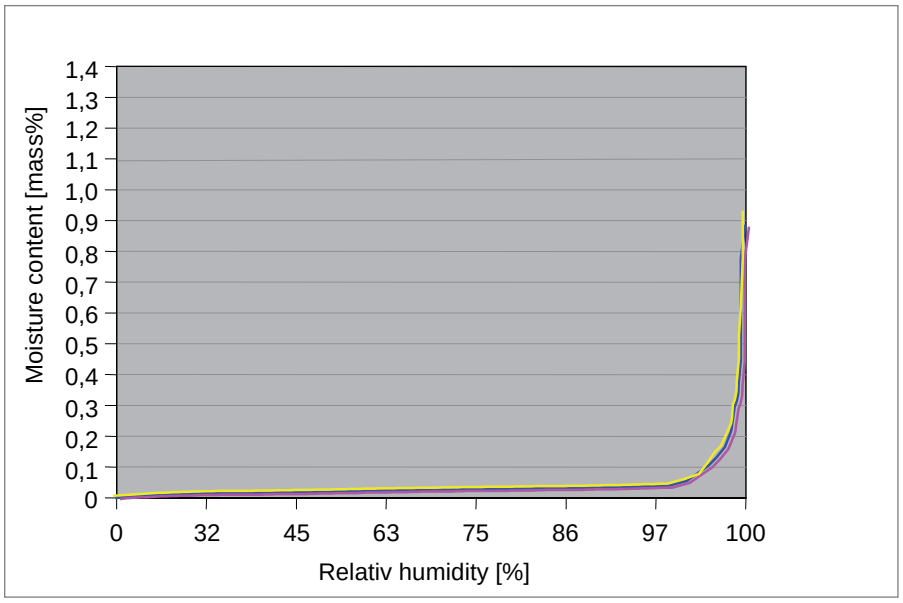
| Relative Humidity [%] | Water Uptake [mass%] | | |
|---|---|---|---|
| | W4 | W5 | W6 |
| 0 | 0,000 | 0,000 | 0,000 |
| 32 | 0,016 | 0,017 | 0,018 |
| 45 | 0,021 | 0,022 | 0,022 |
| 63 | 0,030 | 0,031 | 0,030 |
| 75 | 0,035 | 0,037 | 0,035 |
| 86 | 0,042 | 0,044 | 0,039 |
| 97 | 0,056 | 0,057 | 0,055 |
| immersed in water for 48 hours | 1,15 | 1,15 | 1,15 |



Isothermal Line of Sorption W7, W8, W9 (consolidated samples)

| Messzeitpunkt | W 7-1 | W 7-2 | W 7-3 | Ø W 7 | W 8-1 | W 8-2 | W 8-3 | Ø W 8 | W 9-1 | W 9-2 | W 9-3 | Ø W 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0% RH | | | | | | | | | | | | |
| 26.03.09 | 20,301 | 21,441 | 21,368 | 21,037 | 17,872 | 22,371 | 21,957 | 20,733 | 20,197 | 22,406 | 21,304 | 21,302 |
| 32% RH | | | | | | | | | | | | |
| 30.03.09 09:40 | 20,306 | 21,444 | 21,372 | 21,041 | 17,873 | 22,375 | 21,959 | 20,738 | 20,202 | 22,409 | 21,307 | 21,306 |
| 31.03.09 09:20 | 20,366 | 21,499 | 21,420 | 21,095 | 17,927 | 22,424 | 22,009 | 20,788 | 20,254 | 22,459 | 21,355 | 21,368 |
| 01.04.09 08:45 | 20,368 | 21,507 | 21,430 | 21,102 | 17,928 | 22,434 | 22,020 | 20,784 | 20,262 | 22,470 | 21,365 | 21,366 |
| 02.04.09 09:30 | 20,376 | 21,519 | 21,444 | 21,114 | 17,937 | 22,450 | 22,035 | 20,807 | 20,272 | 22,485 | 21,380 | 21,376 |
| 06.04.09 07:40 | 20,382 | 21,527 | 21,459 | 21,122 | 17,941 | 22,467 | 22,054 | 20,821 | 20,278 | 22,501 | 21,394 | 21,391 |
| 07.04.09 07:30 | 20,381 | 21,527 | 21,461 | 21,123 | 17,942 | 22,467 | 22,053 | 20,821 | 20,280 | 22,501 | 21,395 | 21,392 |
| water absorption | 0,075 | 0,083 | 0,089 | 0,082 | 0,069 | 0,092 | 0,084 | 0,085 | 0,078 | 0,092 | 0,088 | 0,086 |
| water absorption % | 0,016 | 0,018 | 0,019 | 0,017 | 0,012 | 0,021 | 0,021 | 0,018 | 0,016 | 0,021 | 0,019 | 0,018 |
| 45% RH | | | | | | | | | | | | |
| 07.04.09 07:30 | 20,381 | 21,527 | 21,461 | 21,123 | 17,942 | 22,467 | 22,053 | 20,821 | 20,280 | 22,501 | 21,395 | 21,392 |
| 09.04.09 07:40 | 20,394 | 21,542 | 21,479 | 21,138 | 17,954 | 22,485 | 22,072 | 20,837 | 20,293 | 22,518 | 21,413 | 21,408 |
| 14.04.09 07:35 | 20,397 | 21,548 | 21,487 | 21,144 | 17,956 | 22,492 | 22,081 | 20,843 | 20,296 | 22,526 | 21,419 | 21,414 |
| 16.04.09 15:30 | 20,397 | 21,548 | 21,487 | 21,144 | 17,958 | 22,492 | 22,081 | 20,844 | 20,296 | 22,526 | 21,418 | 21,414 |
| water absorption | 0,091 | 0,104 | 0,115 | 0,103 | 0,086 | 0,117 | 0,122 | 0,108 | 0,096 | 0,117 | 0,111 | 0,108 |
| water absorption % | 0,018 | 0,022 | 0,026 | 0,022 | 0,016 | 0,026 | 0,027 | 0,022 | 0,019 | 0,026 | 0,024 | 0,023 |
| 63% RH | | | | | | | | | | | | |
| 16.04.09 15:30 | 20,397 | 21,548 | 21,487 | 21,144 | 17,958 | 22,492 | 22,081 | 20,844 | 20,296 | 22,526 | 21,418 | 21,414 |
| 20.04.09 09:20 | 20,432 | 21,612 | 21,556 | 21,200 | 17,993 | 22,545 | 22,135 | 20,893 | 20,337 | 22,579 | 21,471 | 21,482 |
| 21.04.09 09:50 | 20,430 | 21,600 | 21,549 | 21,193 | 17,989 | 22,545 | 22,140 | 20,891 | 20,335 | 22,575 | 21,471 | 21,480 |
| water absorption | 0,104 | 0,156 | 0,177 | 0,152 | 0,116 | 0,170 | 0,181 | 0,156 | 0,133 | 0,166 | 0,164 | 0,154 |
| water absorption % | 0,026 | 0,038 | 0,038 | 0,032 | 0,021 | 0,038 | 0,040 | 0,032 | 0,027 | 0,037 | 0,036 | 0,033 |
| 75% RH | | | | | | | | | | | | |
| 21.04.09 09:50 | 20,430 | 21,600 | 21,549 | 21,193 | 17,989 | 22,545 | 22,140 | 20,891 | 20,335 | 22,575 | 21,471 | 21,480 |
| 24.04.09 14:10 | 20,446 | 21,626 | 21,594 | 21,222 | 18,006 | 22,581 | 22,182 | 20,923 | 20,355 | 22,612 | 21,510 | 21,492 |
| 28.04.09 09:15 | 20,454 | 21,637 | 21,610 | 21,234 | 18,012 | 22,597 | 22,199 | 20,936 | 20,361 | 22,623 | 21,523 | 21,436 |
| 29.05.09 06:55 | 20,453 | 21,635 | 21,607 | 21,232 | 18,011 | 22,596 | 22,197 | 20,935 | 20,361 | 22,621 | 21,521 | 21,501 |
| water absorption | 0,147 | 0,191 | 0,236 | 0,191 | 0,138 | 0,221 | 0,238 | 0,199 | 0,159 | 0,212 | 0,214 | 0,195 |
| water absorption % | 0,030 | 0,041 | 0,050 | 0,040 | 0,026 | 0,048 | 0,052 | 0,041 | 0,032 | 0,048 | 0,048 | 0,042 |
| 86% RH | | | | | | | | | | | | |
| 29.05.09 06:55 | 20,453 | 21,635 | 21,607 | 21,232 | 18,011 | 22,596 | 22,197 | 20,935 | 20,361 | 22,621 | 21,521 | 21,501 |
| 05.06.09 08:30 | 20,474 | 21,692 | 21,644 | 21,270 | 18,035 | 22,654 | 22,246 | 20,878 | 20,399 | 22,670 | 21,572 | 21,647 |
| 06.06.09 12:00 | 20,473 | 21,690 | 21,639 | 21,267 | 18,036 | 22,654 | 22,240 | 20,877 | 20,398 | 22,670 | 21,569 | 21,646 |
| water absorption | 0,167 | 0,246 | 0,267 | 0,227 | 0,163 | 0,275 | 0,281 | 0,241 | 0,196 | 0,261 | 0,252 | 0,240 |
| water absorption % | 0,034 | 0,063 | 0,067 | 0,042 | 0,029 | 0,062 | 0,062 | 0,050 | 0,040 | 0,058 | 0,058 | 0,051 |
| 97% RH | | | | | | | | | | | | |
| 06.06.09 12:00 | 20,473 | 21,690 | 21,639 | 21,267 | 18,036 | 22,654 | 22,240 | 20,877 | 20,398 | 22,670 | 21,569 | 21,646 |
| 08.06.09 08:40 | 20,509 | 21,751 | 21,642 | 21,304 | 18,092 | 22,668 | 22,245 | 21,003 | 20,446 | 22,714 | 21,598 | 21,586 |
| 12.06.09 07:25 | 20,504 | 21,751 | 21,642 | 21,338 | 18,100 | 22,667 | 22,245 | 21,004 | 20,491 | 22,709 | 21,592 | 21,597 |
| 14.06.09 08:40 | 20,505 | 21,750 | 21,640 | 21,322 | 18,098 | 22,667 | 22,247 | 21,004 | 20,480 | 22,710 | 21,595 | 21,586 |
| water absorption | 0,259 | 0,315 | 0,358 | 0,281 | 0,225 | 0,292 | 0,288 | 0,268 | 0,278 | 0,301 | 0,289 | 0,289 |
| water absorption % | 0,063 | 0,068 | 0,067 | 0,059 | 0,040 | 0,066 | 0,060 | 0,056 | 0,056 | 0,067 | 0,061 | 0,062 |

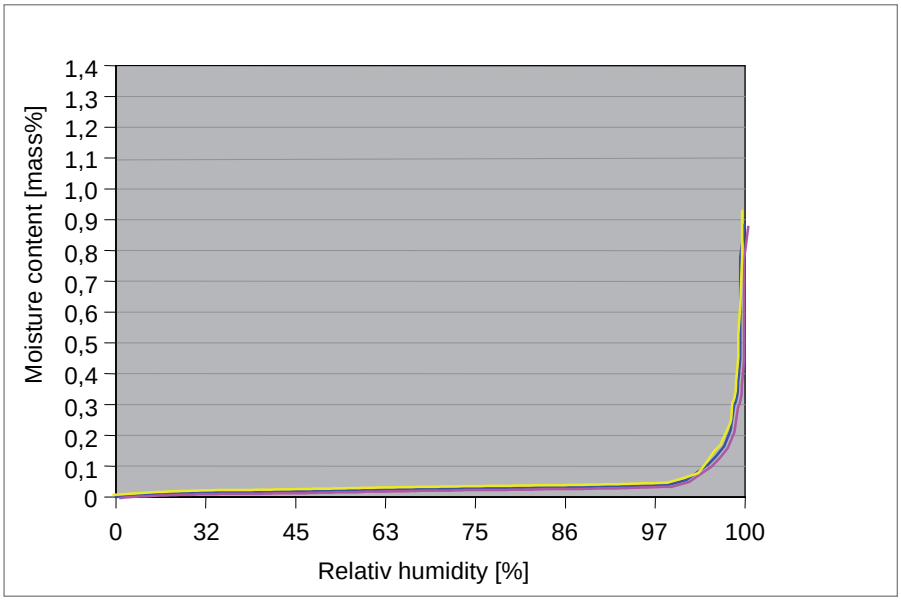
| Relative Humidity [%] | Water Uptake [mass%] | | |
|---|---|---|---|
| | W7 | W8 | W9 |
| 0 | 0,000 | 0,000 | 0,000 |
| 32 | 0,017 | 0,018 | 0,018 |
| 45 | 0,022 | 0,022 | 0,023 |
| 63 | 0,032 | 0,032 | 0,033 |
| 75 | 0,040 | 0,041 | 0,042 |
| 86 | 0,048 | 0,050 | 0,051 |
| 97 | 0,059 | 0,056 | 0,062 |
| immersed in water for 48 hours | 0,80 | 0,49 | 0,85 |



Isothermal Line of Sorption W10, W11, W12 (consolidated samples)

| Messzeitpunkt | W 10-1 | W 10-2 | W 10-3 | Ø W 10 | W 11-1 | W 11-2 | W 11-3 | Ø W 11 | W 12-1 | W 12-2 | W 12-3 | Ø W 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0% RH | | | | | | | | | | | | |
| 25.03.09 | 18,444 | 22,070 | 22,864 | 21,126 | 20,113 | 22,996 | 22,085 | 21,731 | 18,448 | 21,520 | 22,926 | 20,965 |
| 32% RH | | | | | | | | | | | | |
| 31.03.09 09:25 | 18,444 | 22,076 | 22,869 | 21,130 | 20,115 | 23,000 | 22,089 | 21,735 | 18,451 | 21,522 | 22,928 | 20,967 |
| 01.04.09 09:55 | 18,498 | 22,123 | 22,910 | 21,177 | 20,165 | 23,044 | 22,131 | 21,780 | 18,494 | 21,566 | 22,969 | 21,010 |
| 02.04.09 09:30 | 18,513 | 22,143 | 22,933 | 21,198 | 20,185 | 23,067 | 22,154 | 21,802 | 18,513 | 21,588 | 22,992 | 21,031 |
| 06.04.09 07:35 | 18,519 | 22,163 | 22,961 | 21,214 | 20,196 | 23,093 | 22,180 | 21,823 | 18,519 | 21,604 | 23,014 | 21,046 |
| 07.04.09 07:45 | 18,520 | 22,165 | 22,962 | 21,218 | 20,194 | 23,095 | 22,180 | 21,823 | 18,520 | 21,605 | 23,013 | 21,046 |
| water absorption | 0,075 | 0,089 | 0,093 | 0,086 | 0,075 | 0,095 | 0,091 | 0,088 | 0,069 | 0,083 | 0,085 | 0,079 |
| water absorption % | 0,014 | 0,020 | 0,021 | 0,018 | 0,018 | 0,022 | 0,020 | 0,018 | 0,013 | 0,018 | 0,018 | 0,017 |
| 45% RH | | | | | | | | | | | | |
| 07.04.09 07:45 | 18,520 | 22,165 | 22,962 | 21,218 | 20,194 | 23,095 | 22,180 | 21,823 | 18,520 | 21,605 | 23,013 | 21,046 |
| 09.04.09 07:50 | 18,531 | 22,181 | 22,980 | 21,231 | 20,208 | 23,112 | 22,198 | 21,839 | 18,531 | 21,622 | 23,033 | 21,062 |
| 14.04.09 07:30 | 18,534 | 22,192 | 22,991 | 21,239 | 20,215 | 23,124 | 22,210 | 21,850 | 18,536 | 21,631 | 23,042 | 21,070 |
| 14.04.09 15:25 | 18,536 | 22,190 | 22,991 | 21,239 | 20,214 | 23,122 | 22,209 | 21,848 | 18,537 | 21,632 | 23,042 | 21,070 |
| water absorption | 0,092 | 0,114 | 0,122 | 0,109 | 0,099 | 0,122 | 0,120 | 0,114 | 0,085 | 0,110 | 0,114 | 0,103 |
| water absorption % | 0,017 | 0,025 | 0,028 | 0,023 | 0,020 | 0,028 | 0,027 | 0,025 | 0,016 | 0,024 | 0,026 | 0,022 |
| 63% RH | | | | | | | | | | | | |
| 14.04.09 15:25 | 18,536 | 22,190 | 22,991 | 21,239 | 20,214 | 23,122 | 22,209 | 21,848 | 18,537 | 21,632 | 23,042 | 21,070 |
| 20.04.09 09:30 | 18,569 | 22,238 | 23,047 | 21,285 | 20,252 | 23,176 | 22,266 | 21,898 | 18,571 | 21,681 | 23,097 | 21,116 |
| 21.04.09 09:50 | 18,566 | 22,236 | 23,046 | 21,283 | 20,252 | 23,176 | 22,265 | 21,898 | 18,569 | 21,680 | 23,095 | 21,115 |
| water absorption | 0,122 | 0,160 | 0,177 | 0,153 | 0,137 | 0,176 | 0,176 | 0,153 | 0,119 | 0,158 | 0,167 | 0,148 |
| water absorption % | 0,023 | 0,036 | 0,040 | 0,032 | 0,028 | 0,040 | 0,039 | 0,035 | 0,022 | 0,034 | 0,038 | 0,031 |
| 75% RH | | | | | | | | | | | | |
| 21.04.09 09:50 | 18,566 | 22,236 | 23,046 | 21,283 | 20,252 | 23,176 | 22,265 | 21,898 | 18,569 | 21,680 | 23,095 | 21,115 |
| 24.04.09 14:00 | 18,588 | 22,270 | 23,098 | 21,318 | 20,271 | 23,219 | 22,318 | 21,936 | 18,589 | 21,712 | 23,137 | 21,146 |
| 28.04.09 09:20 | 18,592 | 22,273 | 23,111 | 21,326 | 20,277 | 23,232 | 22,332 | 21,947 | 18,593 | 21,720 | 23,152 | 21,155 |
| 29.04.09 07:00 | 18,592 | 22,278 | 23,110 | 21,327 | 20,278 | 23,232 | 22,331 | 21,947 | 18,593 | 21,720 | 23,150 | 21,154 |
| water absorption | 0,148 | 0,202 | 0,241 | 0,197 | 0,163 | 0,232 | 0,242 | 0,212 | 0,142 | 0,198 | 0,222 | 0,187 |
| water absorption % | 0,027 | 0,046 | 0,056 | 0,042 | 0,030 | 0,053 | 0,053 | 0,048 | 0,026 | 0,043 | 0,051 | 0,039 |
| 86% RH | | | | | | | | | | | | |
| 29.04.09 07:00 | 18,592 | 22,278 | 23,110 | 21,327 | 20,278 | 23,232 | 22,331 | 21,947 | 18,593 | 21,720 | 23,150 | 21,154 |
| 05.05.09 08:30 | 18,613 | 22,325 | 23,164 | 21,367 | 20,320 | 23,296 | 22,381 | 21,988 | 18,630 | 21,771 | 23,206 | 21,202 |
| 06.05.09 12:00 | 18,612 | 22,322 | 23,160 | 21,365 | 20,323 | 23,294 | 22,378 | 21,983 | 18,627 | 21,769 | 23,205 | 21,200 |
| 08.05.09 08:40 | 18,617 | 22,330 | 23,169 | 21,372 | 20,324 | 23,302 | 22,381 | 22,002 | 18,629 | 21,773 | 23,204 | 21,202 |
| water absorption | 0,173 | 0,254 | 0,300 | 0,242 | 0,209 | 0,302 | 0,292 | 0,258 | 0,178 | 0,251 | 0,276 | 0,235 |
| water absorption % | 0,032 | 0,068 | 0,089 | 0,061 | 0,042 | 0,089 | 0,064 | 0,058 | 0,033 | 0,054 | 0,063 | 0,048 |
| 97% RH | | | | | | | | | | | | |
| 12.05.09 07:20 | 18,617 | 22,330 | 23,169 | 21,372 | 20,324 | 23,302 | 22,381 | 22,002 | 18,629 | 21,773 | 23,204 | 21,202 |
| 14.05.09 08:40 | 18,652 | 22,396 | 23,174 | 21,407 | 20,373 | 23,319 | 22,380 | 22,024 | 18,672 | 21,824 | 23,225 | 21,240 |
| 18.05.09 09:20 | 18,660 | 22,439 | 23,209 | 21,436 | 20,410 | 23,334 | 22,379 | 22,041 | 18,702 | 21,867 | 23,228 | 21,266 |
| 19.05.09 08:30 | 18,676 | 22,430 | 23,190 | 21,432 | 20,406 | 23,330 | 22,380 | 22,039 | 18,699 | 21,860 | 23,220 | 21,260 |
| water absorption | 0,232 | 0,354 | 0,321 | 0,302 | 0,291 | 0,330 | 0,299 | 0,304 | 0,248 | 0,338 | 0,292 | 0,293 |
| water absorption % | 0,043 | 0,078 | 0,073 | 0,064 | 0,058 | 0,078 | 0,064 | 0,066 | 0,048 | 0,073 | 0,067 | 0,061 |

| Relative Humidity [%] | Water Uptake [mass%] | | |
|---|---|---|---|
| | W10 | W11 | W12 |
| 0 | 0,000 | 0,000 | 0,000 |
| 32 | 0,018 | 0,019 | 0,017 |
| 45 | 0,023 | 0,025 | 0,022 |
| 63 | 0,032 | 0,035 | 0,031 |
| 75 | 0,042 | 0,046 | 0,039 |
| 86 | 0,051 | 0,058 | 0,049 |
| 97 | 0,064 | 0,066 | 0,061 |
| immersed in water for 48 hours | 0,89 | 0,82 | 0,77 |



# Biegezugmessung/Biaxial Flexural Strength

## Parameter

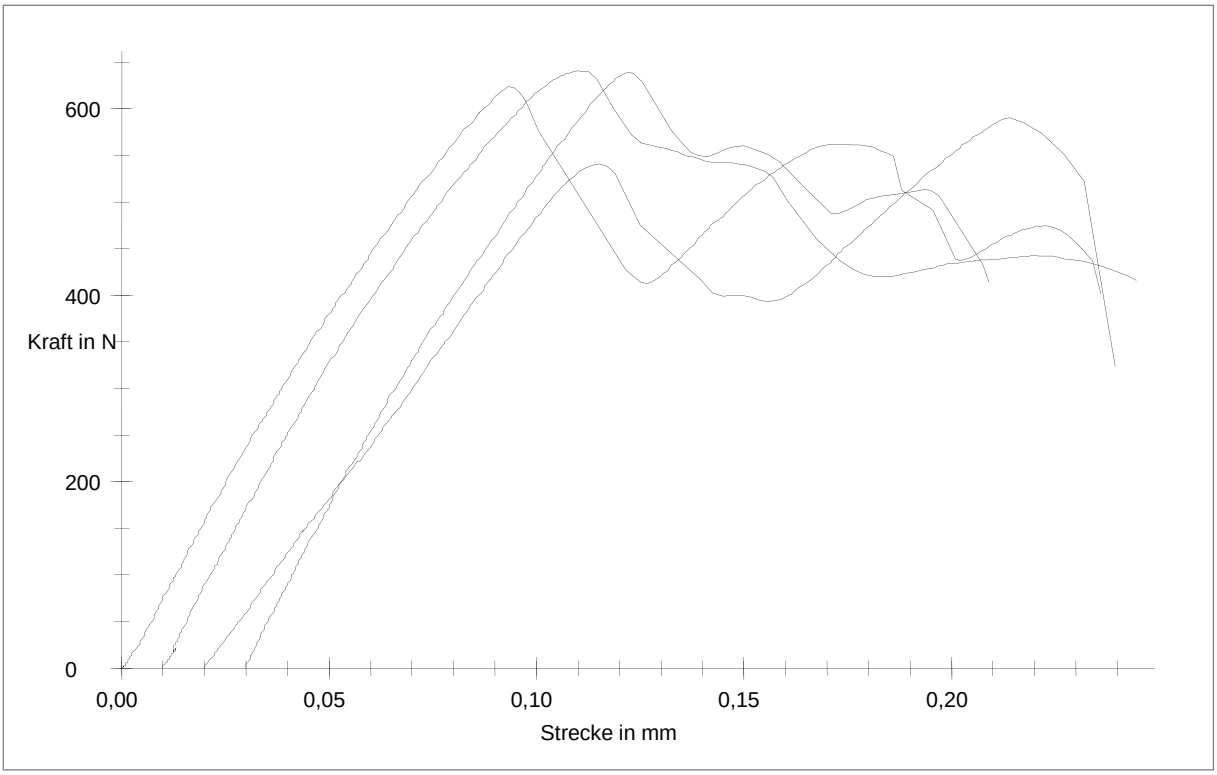
| | |
|---|---|
| Material | sandstone Jinchuanwan Grotto |
| Tester | Martina Klukas |
| Preliminary test force | 5,00 N |
| Radius upper ring | 6,50 mm |
| Radius bearing ring | 19,50 mm |
| Additional force in steps of | 0,50 mm/min |

## Samples W1:

Samples untreated

| Sample | d [mm] | Ø $d_0$ [mm] | $F_{max}$ [N] | $\delta_{BZ}$ [N/mm²] | L ($F_{max}$) [mm] | E-modulus [kN/mm²] | $f_0$ [mm] | Time-$F_{max}$ [s] |
|---|---|---|---|---|---|---|---|---|
| **W1-1** | 5,60 | 44,5 | 623,62 | 15,47 | 0,09 | 25,07 | 0,026 | 26,86 |
| **W1-2** | 5,30 | 44,5 | 640,63 | 17,74 | 0,10 | 31,09 | 0,025 | 29,88 |
| **W1-3** | 5,40 | 44,5 | 590,56 | 16,36 | 0,19 | 22,48 | 0,033 | 30,02 |
| **W1-4** | 5,40 | 44,5 | 639,30 | 17,06 | 0,09 | 30,56 | 0,024 | 22,46 |
| **Ø W1** | | | | 16,66 | | 27,30 | | |

## Graphic:

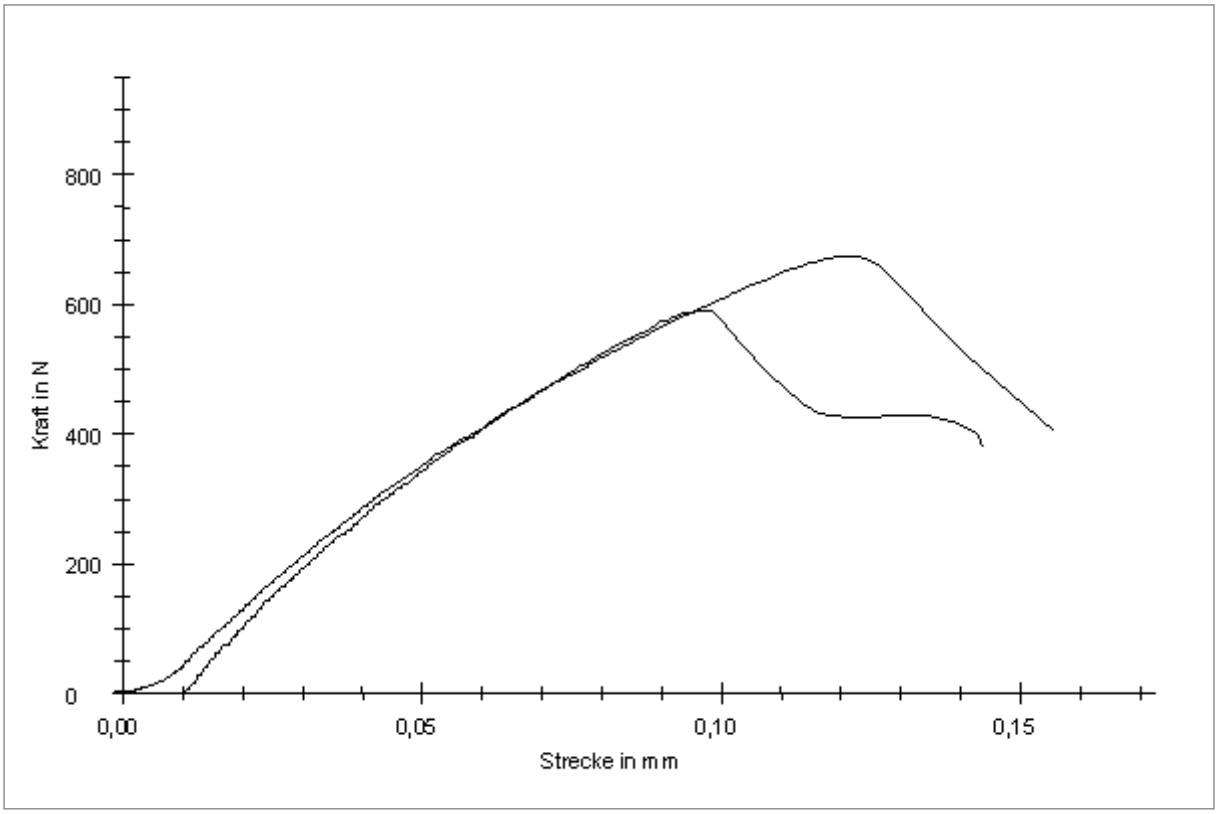


## Samples W2:

Samples untreated

| Sample | d [mm] | Ø $d_0$ [mm] | $F_{max}$ [N] | $\delta_{BZ}$ [N/mm²] | L ($F_{max}$) [mm] | E-modulus [kN/mm²] | $f_0$ [mm] | Time-$F_{max}$ [s] |
|---|---|---|---|---|---|---|---|---|
| **W2-1** | 5,40 | 45,7 | 675,40 | 17,87 | 0,12 | 24,99 | 0,032 | 33,28 |
| **W2-2** | 5,60 | 45,7 | 591,01 | 15,64 | 0,09 | 33,52 | 0,021 | 25,16 |
| **W2-3** | sample not evaluable | | | | | | | |
| **W2-4** | sample not evaluable | | | | | | | |
| **Ø W2** | | | | 16,76 | | 29,26 | | |

## Graphic:

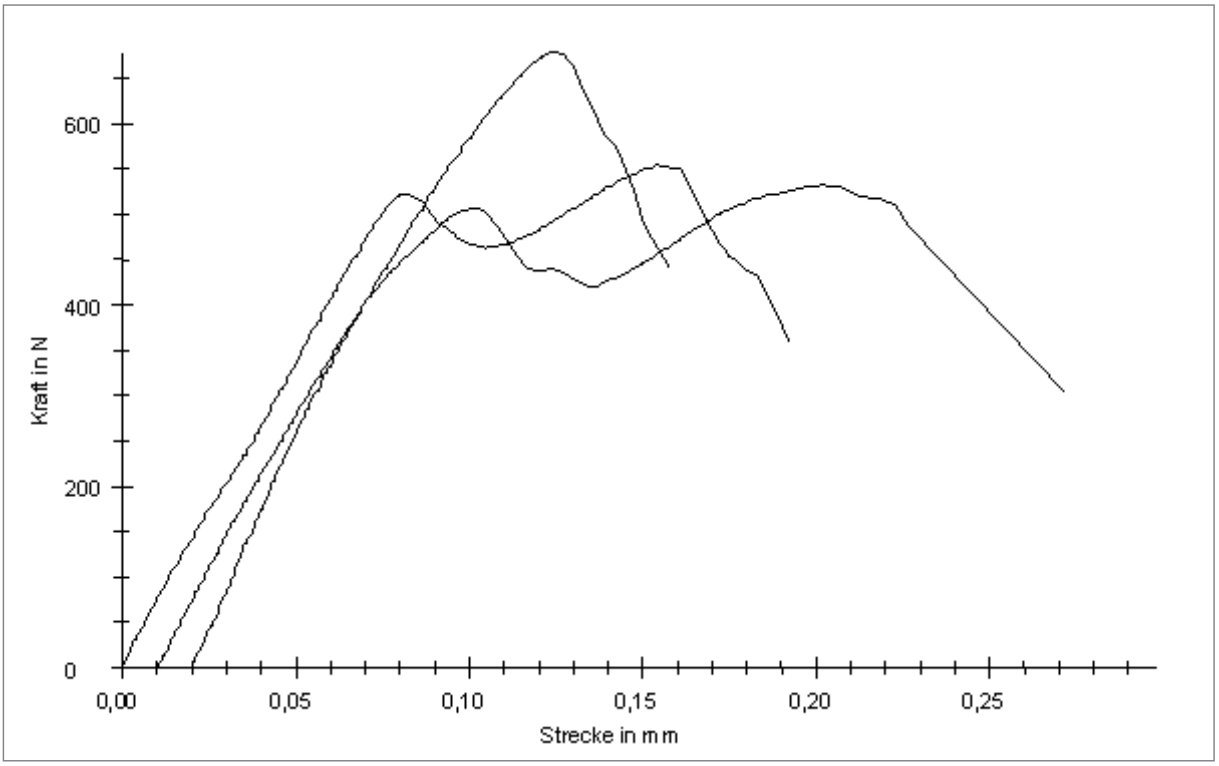


## Samples W3:

Samples untreated

| Sample | d [mm] | Ø $d_0$ [mm] | $F_{max}$ [N] | $\delta_{BZ}$ [N/mm²] | L ($F_{max}$) [mm] | E-modulus [kN/mm²] | $f_0$ [mm] | Time-$F_{max}$ [s] |
|---|---|---|---|---|---|---|---|---|
| **W3-1** | 5,50 | 44,5 | 553,90 | 14,24 | 0,15 | 22,86 | 0,027 | 28,72 |
| **W3-2** | 5,50 | 44,5 | 532,47 | 13,69 | 0,19 | 24,12 | 0,024 | 29,30 |
| **W3-3** | 5,40 | 44,5 | 678,72 | 18,11 | 0,10 | 30,32 | 0,026 | 23,22 |
| **W3-4** | sample not evaluable | | | | | | | |
| **Ø W3** | | | | 15,35 | | 25,77 | | |

## Graphic:

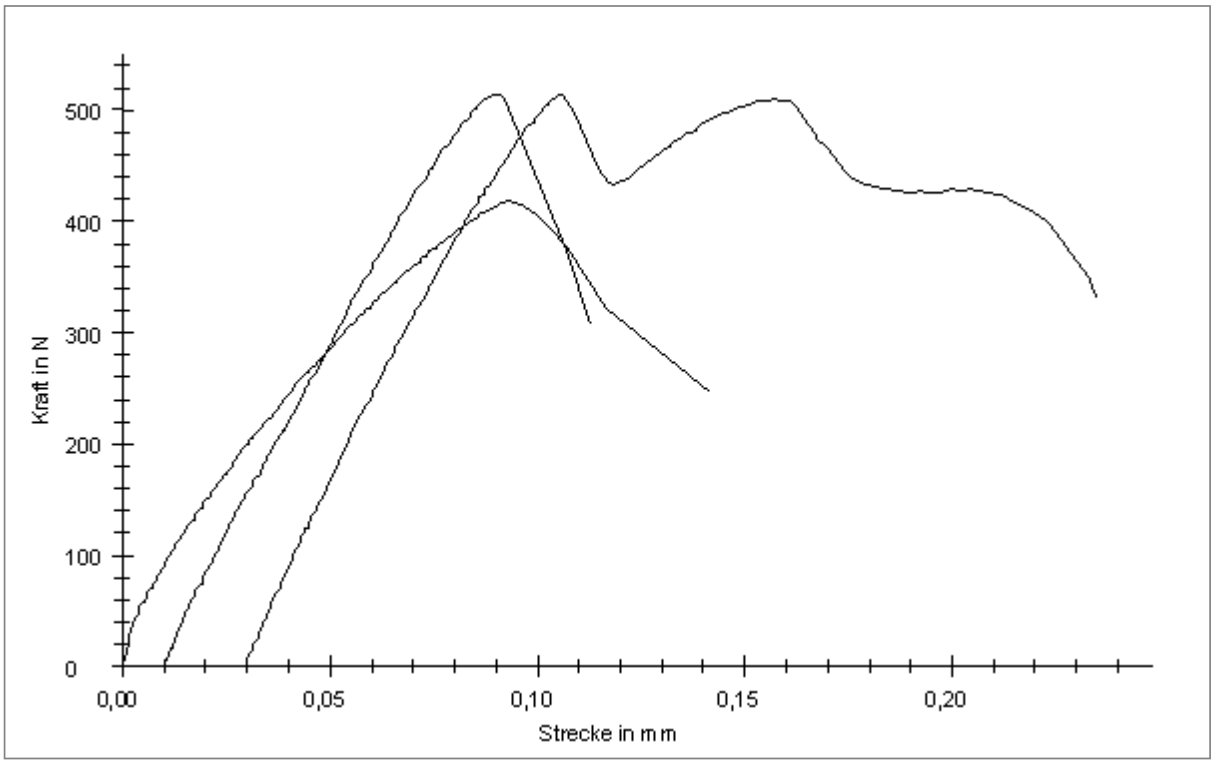


## Samples W4:

Samples untreated

| Sample | d | Ø $d_0$ | $F_{max}$ | $\delta_{BZ}$ | L ($F_{max}$) | E-modulus | $f_0$ | Time- |
|---|---|---|---|---|---|---|---|---|
| | [mm] | [mm] | [N] | [N/mm²] | [mm] | [kN/mm²] | [mm] | [s |
| **W4-1** | 5,90 | 44,5 | 418,28 | 11,16 | 0,09 | 26,70 | 0,018 | 22, |
| **W4-2** | 5,40 | 44,5 | 514,13 | 13,72 | 0,08 | 26,69 | 0,023 | 20, |
| **W4-3** | sample not evaluable | | | | | | | |
| **W4-4** | 5,40 | 44,5 | 514,03 | 13,71 | 0,08 | 29,18 | 0,021 | 17, |
| **Ø W4** | | | | 12,86 | | 27,52 | | |

## Graphic:

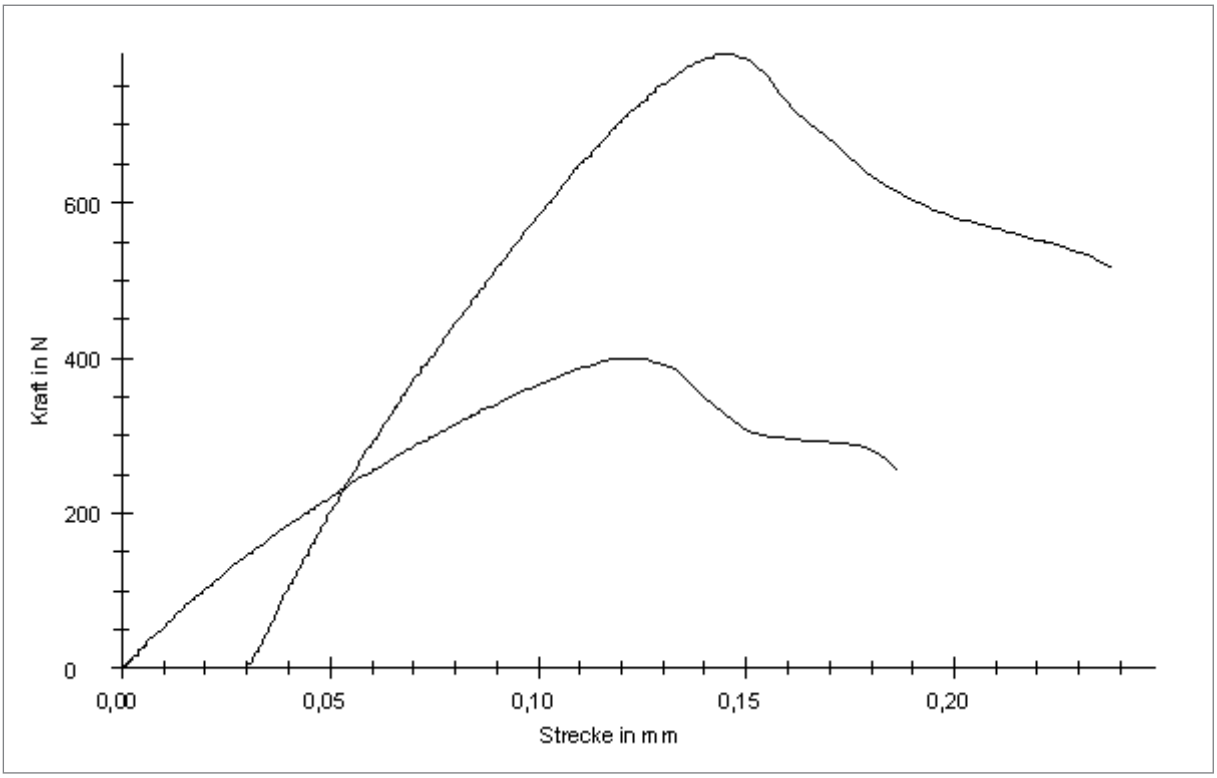


## Samples W5:

Samples untreated

| Sample | d [mm] | Ø $d_0$ [mm] | $F_{max}$ [N] | $\delta_{BZ}$ [N/mm²] | L ($F_{max}$) [mm] | E-modulus [kN/mm²] | $f_0$ [mm] | Time-$F_{max}$ [s] |
|---|---|---|---|---|---|---|---|---|
| **W5-1** | 4,50 | 44,5 | 399,93 | 15,36 | 0,12 | 30,04 | 0,027 | 25,10 |
| **W5-2** | sample not evaluable | | | | | | | |
| **W5-3** | sample not evaluable | | | | | | | |
| **W5-4** | 5,40 | 44,5 | 791,58 | 20,36 | 0,12 | 32,46 | 0,027 | 25,06 |
| **∅ W5** | | | | 17,86 | | 31,43 | | |

## Graphic:

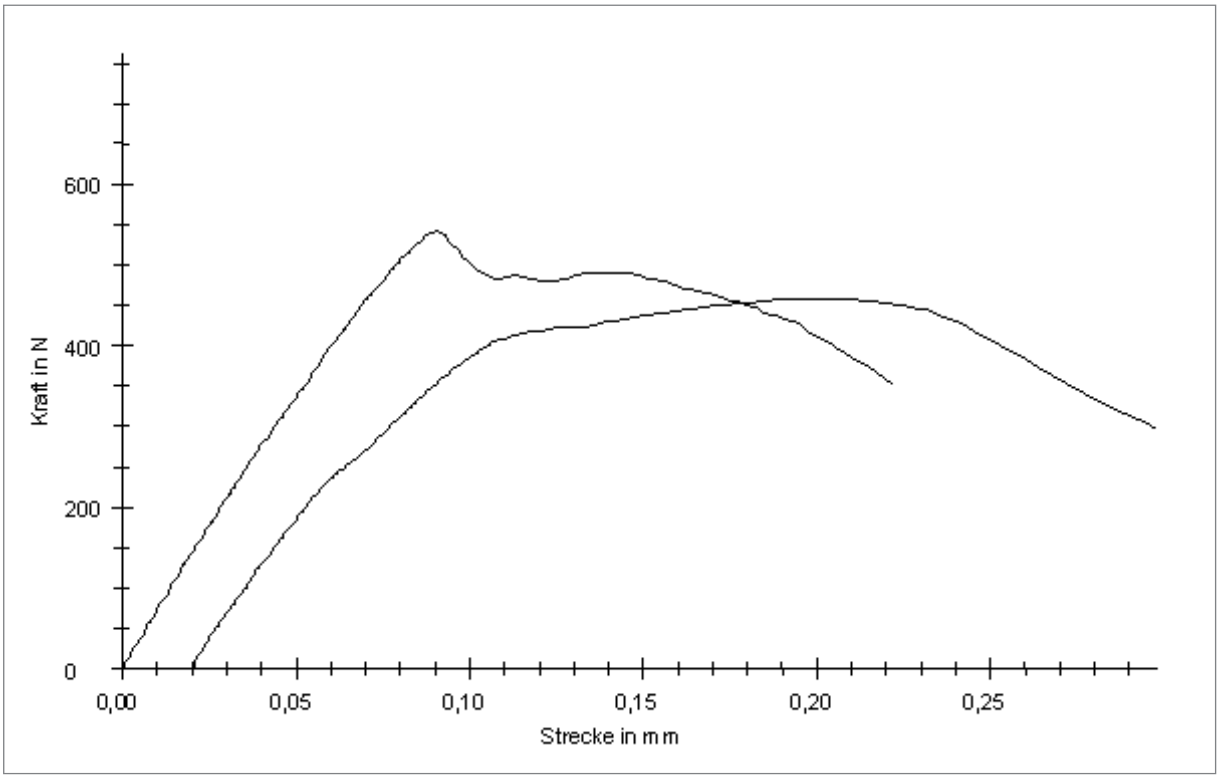


## Samples W6:

Samples untreated

| Sample | d [mm] | Ø $d_0$ [mm] | $F_{max}$ [N] | $\delta_{BZ}$ [N/mm²] | L ($F_{max}$) [mm] | E-modulus [kN/mm²] | $f_0$ [mm] | Time-$F_{max}$ [s] |
|---|---|---|---|---|---|---|---|---|
| **W6-1** | 5,40 | 44,5 | 541,50 | 14,45 | 0,09 | 24,84 | 0,026 | 21,02 |
| **W6-2** | sample not evaluable | | | | | | | |
| **W6-3** | 5,30 | 44,5 | 458,43 | 12,70 | 0,18 | 23,52 | 0,024 | 22,48 |
| **W6-4** | sample not evaluable | | | | | | | |
| **∅ W6** | | | | 13,58 | | 24,18 | | |

## Graphic:

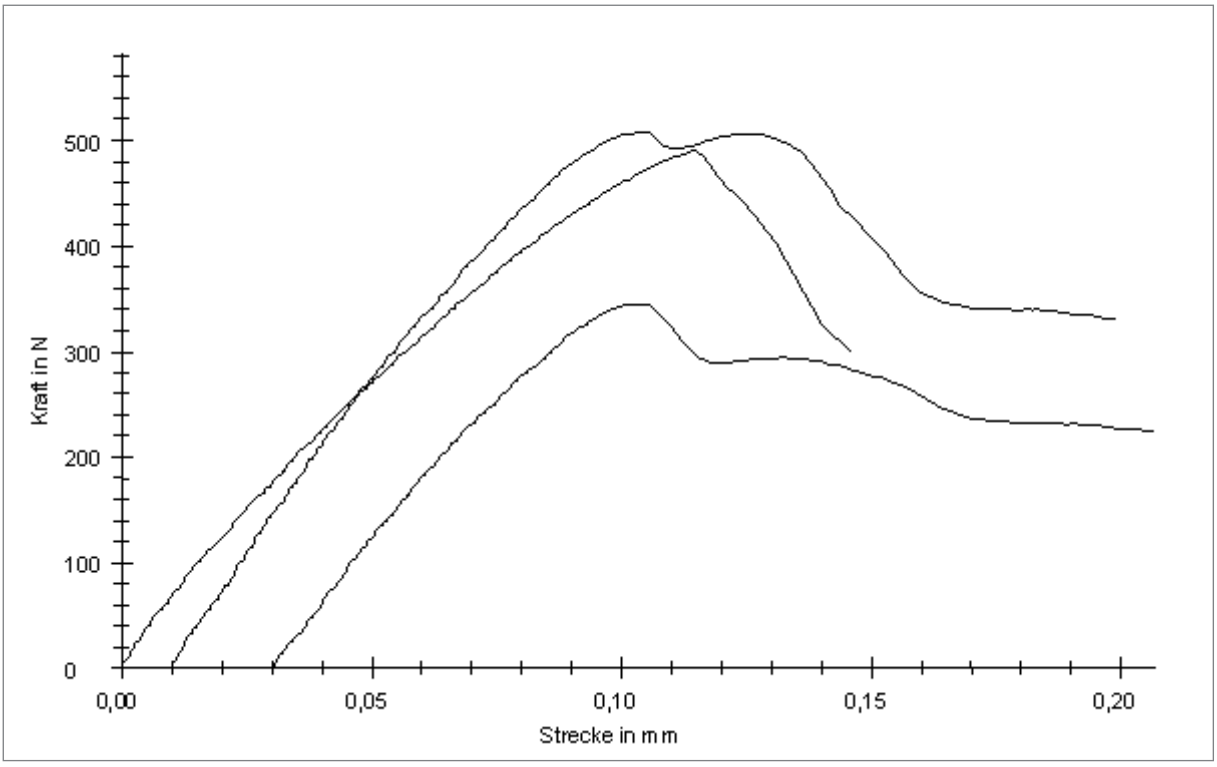


## Samples W7:

Consolidation: soaked KSE OH

| Sample | d [mm] | Ø $d_0$ [mm] | $F_{max}$ [N] | $\delta_{BZ}$ [N/mm²] | L ($F_{max}$) [mm] | E-modulus [kN/mm²] | $f_0$ [mm] | Time-$F_{max}$ [s] |
|---|---|---|---|---|---|---|---|---|
| **W7-1** | 5,20 | 44,5 | 489,96 | 14,10 | 0,11 | 23,51 | 0,027 | 21,40 |
| **W7-2** | 5,40 | 44,5 | 507,67 | 13,54 | 0,09 | 25,22 | 0,024 | 19,68 |
| **W7-3** | sample not evaluable | | | | | | | |
| **W7-4** | 4,40 | 44,5 | 345,02 | 13,86 | 0,07 | 40,28 | 0,019 | 14,70 |
| **Ø W7** | | | | 13,83 | | 29,67 | | |

## Graphic:

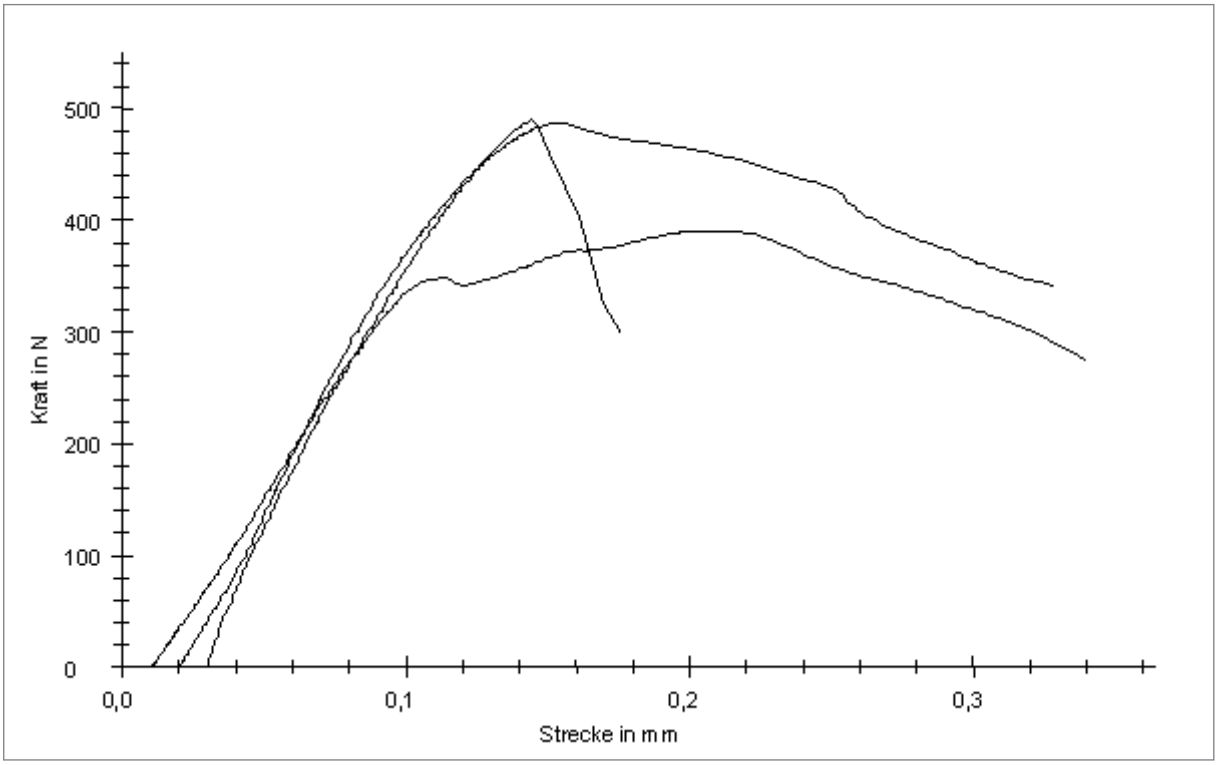


## Samples W8:

Consolidation: KSE OH, 1 min/side

| Sample | d [mm] | Ø $d_0$ [mm] | $F_{max}$ [N] | $\delta_{BZ}$ [N/mm²] | L ($F_{max}$) [mm] | E-modulus [kN/mm²] | $f_0$ [mm] | Time-$F_{max}$ [s] |
|---|---|---|---|---|---|---|---|---|
| **W8-1** | sample not evaluable | | | | | | | |
| **W8-2** | 5,60 | 44,5 | 390,97 | 13,66 | 0,20 | 34,41 | 0,035 | 33,84 |
| **W8-3** | 5,50 | 44,5 | 486,76 | 15,78 | 0,14 | 38,82 | 0,035 | 27,26 |
| **W8-4** | 5,40 | 44,5 | 489,96 | 14,10 | 0,11 | 23,51 | 0,027 | 21,40 |
| **Ø W8** | | | | 14,48 | | 32,25 | | |

## Graphic:

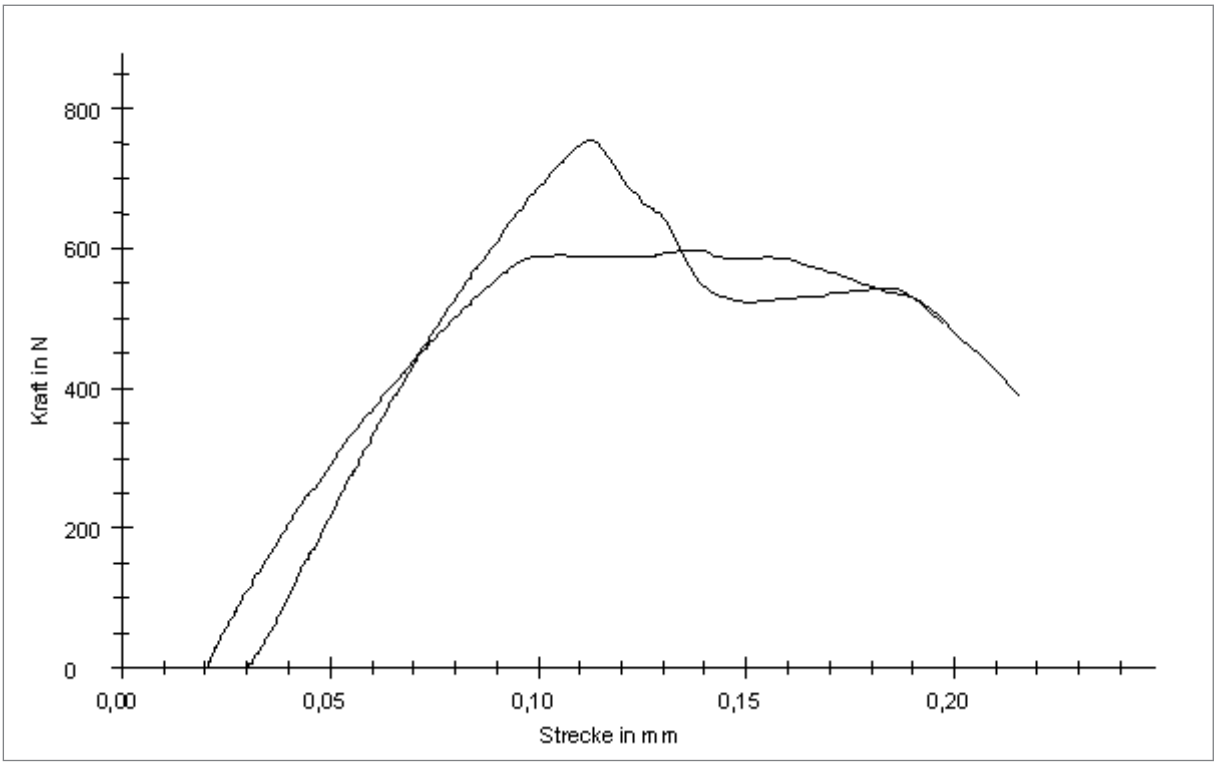


## Samples W9:

Consolidation: soaked KSE 100

| Sample | d [mm] | Ø $d_0$ [mm] | $F_{max}$ [N] | $\delta_{BZ}$ [N/mm²] | L ($F_{max}$) [mm] | E-modulus [kN/mm²] | $f_0$ [mm] | Time-$F_{max}$ [s] |
|---|---|---|---|---|---|---|---|---|
| **W9-1** | sample not evaluable | | | | | | | |
| **W9-2** | sample not evaluable | | | | | | | |
| **W9-3** | 5,30 | 44,5 | 598,09 | 16,56 | 0,12 | 37,95 | 0,020 | 26,22 |
| **W9-4** | 5,50 | 44,5 | 754,00 | 19,39 | 0,08 | 36,76 | 0,023 | 25,82 |
| **Ø W9** | | | | 17,96 | | 37,35 | | |

## Graphic:

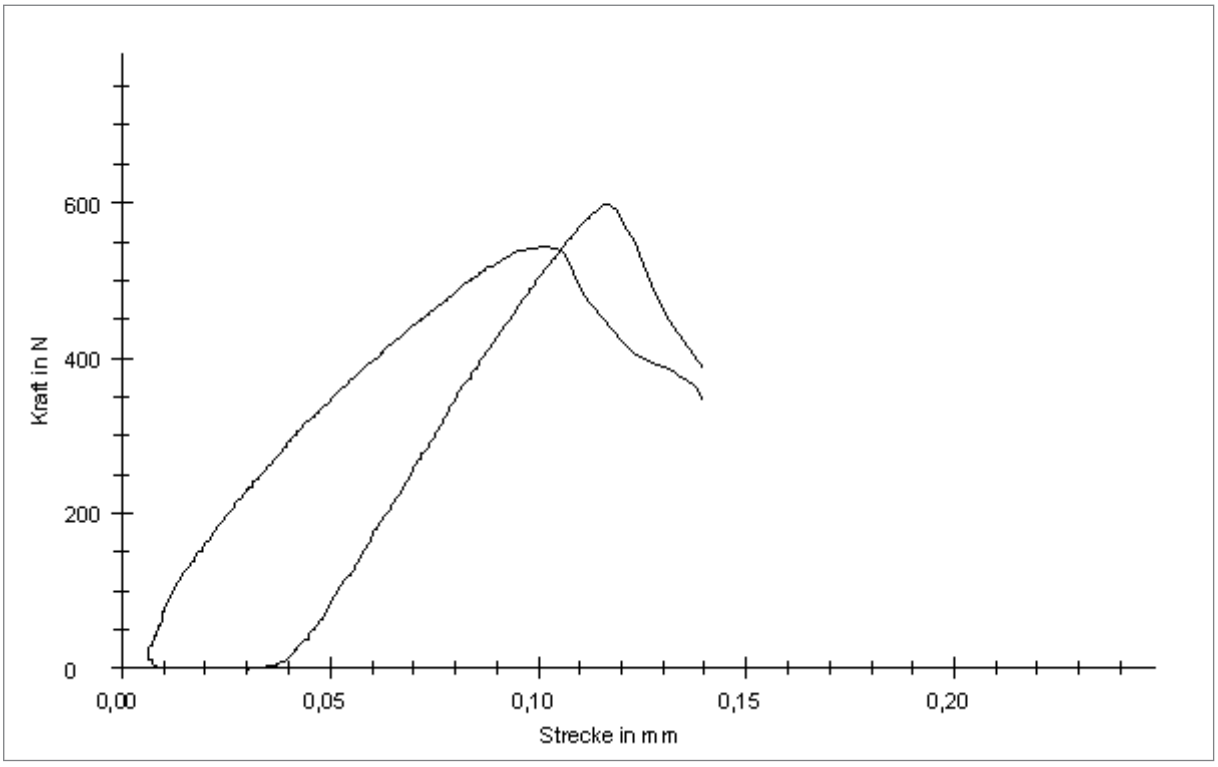


## Samples W10:

Consolidation: KSE 100, 1 min/side

| Sample | d [mm] | Ø $d_0$ [mm] | $F_{max}$ [N] | $\delta_{BZ}$ [N/mm²] | L ($F_{max}$) [mm] | E-modulus [kN/mm²] | $f_0$ [mm] | Time-$F_{max}$ [s] |
|---|---|---|---|---|---|---|---|---|
| **W10-1** | sample not evaluable | | | | | | | |
| **W10-2** | sample not evaluable | | | | | | | |
| **W10-3** | 5,70 | 44,5 | 704,53 | 16,87 | 0,10 | 27,48 | 0,026 | 23,24 |
| **W10-4** | 5,40 | 44,5 | 598,03 | 15,95 | 0,09 | 20,92 | 0,033 | 27,72 |
| **Ø W10** | | | | 16,41 | | 24,2 | | |

## Graphic:

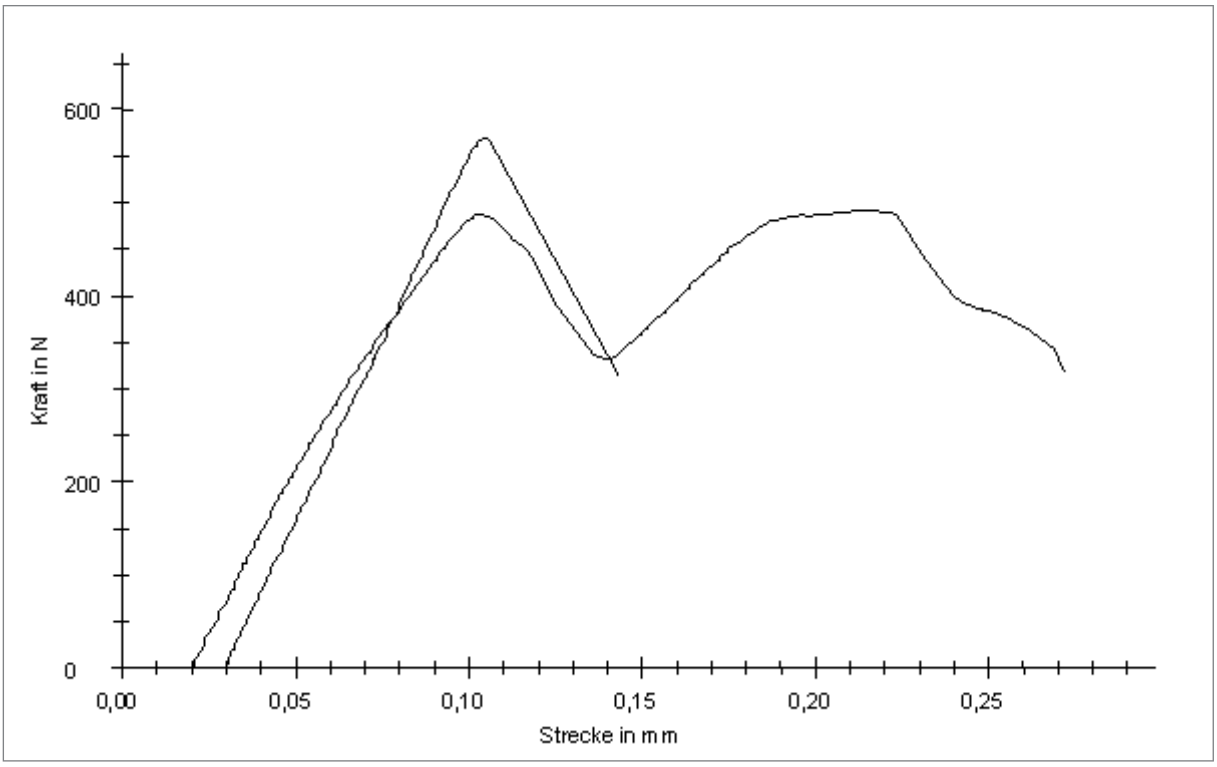


## Samples W11:

Consolidation: KSE 300, 1 min/side

| Sample | d [mm] | Ø $d_0$ [mm] | $F_{max}$ [N] | $\delta_{BZ}$ [N/mm²] | L ($F_{max}$) [mm] | E-modulus [kN/mm²] | $f_0$ [mm] | Time-$F_{max}$ [s] |
|---|---|---|---|---|---|---|---|---|
| **W11-1** | sample not evaluable | | | | | | | |
| **W11-2** | sample not evaluable | | | | | | | |
| **W11-3** | 5,50 | 44,5 | 492,63 | 13,64 | 0,19 | 26,85 | 0,023 | 30,84 |
| **W11-4** | 5,50 | 44,5 | 570,40 | 14,67 | 0,07 | 26,10 | 0,024 | 18,30 |
| **Ø W11** | | | | 14,16 | | 26,48 | | |

## Graphic:

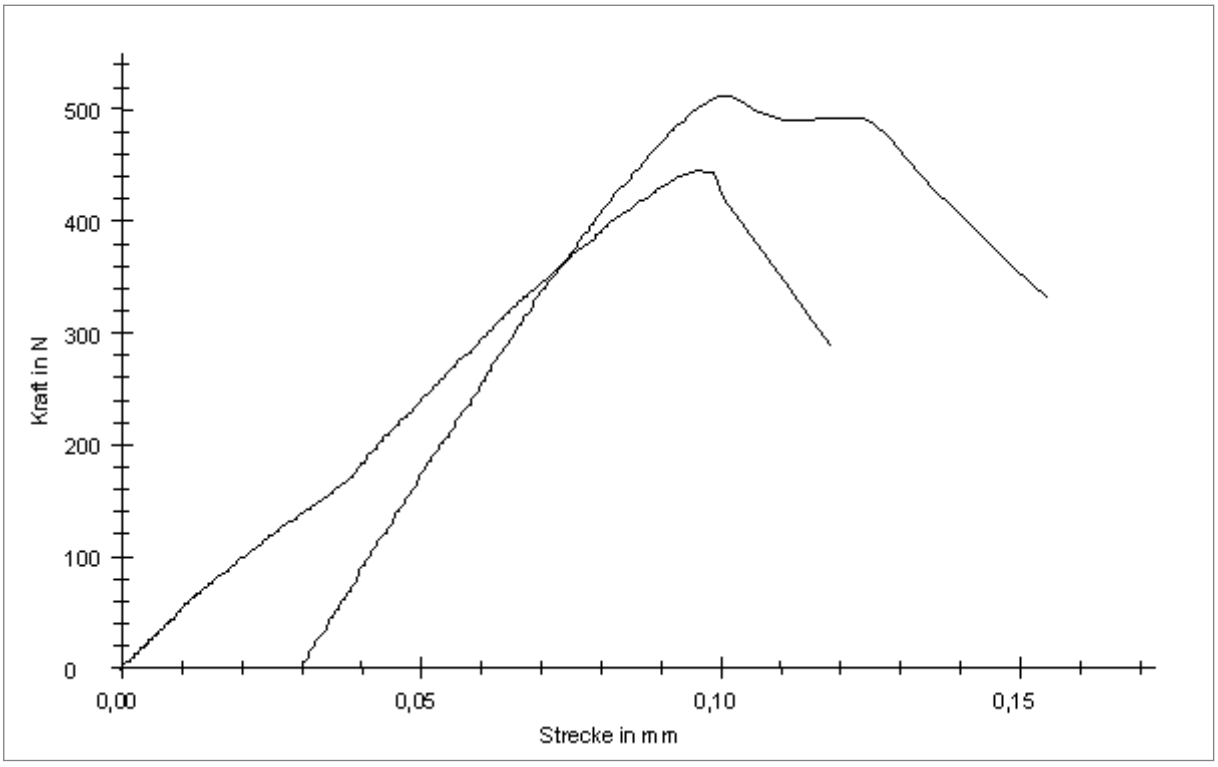


## Samples W12:

Consolidation: soaked KSE 300

| Sample | d [mm] | Ø $d_0$ [mm] | $F_{max}$ [N] | $\delta_{BZ}$ [N/mm²] | L ($F_{max}$) [mm] | E-modulus [kN/mm²] | $f_0$ [mm] | Time-$F_{max}$ [s] |
|---|---|---|---|---|---|---|---|---|
| **W12-1** | 4,70 | 44,5 | 444,99 | 14,42 | 0,10 | 21,41 | 0,033 | 30,36 |
| **W12-2** | sample not evaluable | | | | | | | |
| **W12-3** | sample not evaluable | | | | | | | |
| **W12-4** | 4,90 | 44,5 | 512,21 | 16,60 | 0,07 | 41,13 | 0,020 | 19,54 |
| **Ø W12** | | | | 15,51 | | 31,27 | | |

## Graphic:



## Biegezugmessung Zusammenfassung/Results Biaxial Flexural Strength

| Sample | Consolidation | $\delta_{BZ}$ [N/mm²] | E-modulus [kN/mm²] |
|---|---|---|---|
| W1 | untreated | 16, 7 | 27,3 |
| W2 | untreated | 16,8 | 29,3 |
| W3 | untreated | 15,4 | 25,8 |
| W4 | untreated | 12,9 | 27,5 |
| W5 | untreated | 17,9 | 31,4 |
| W6 | untreated | 13,6 | 24,2 |
| W7 | soaked KSE OH | 13,8 | 29,7 |
| W8 | KSE OH 1 min/side | 14,1 | 32,3 |
| W9 | soaked KSE 100 | 18,0 | 37,4 |
| W10 | KSE 100 1 min/side | 16,4 | 24,2 |
| W11 | KSE 300 1 min/side | 14,2 | 26,5 |
| W12 | soaked KSE 300 | 15,5 | 31,3 |

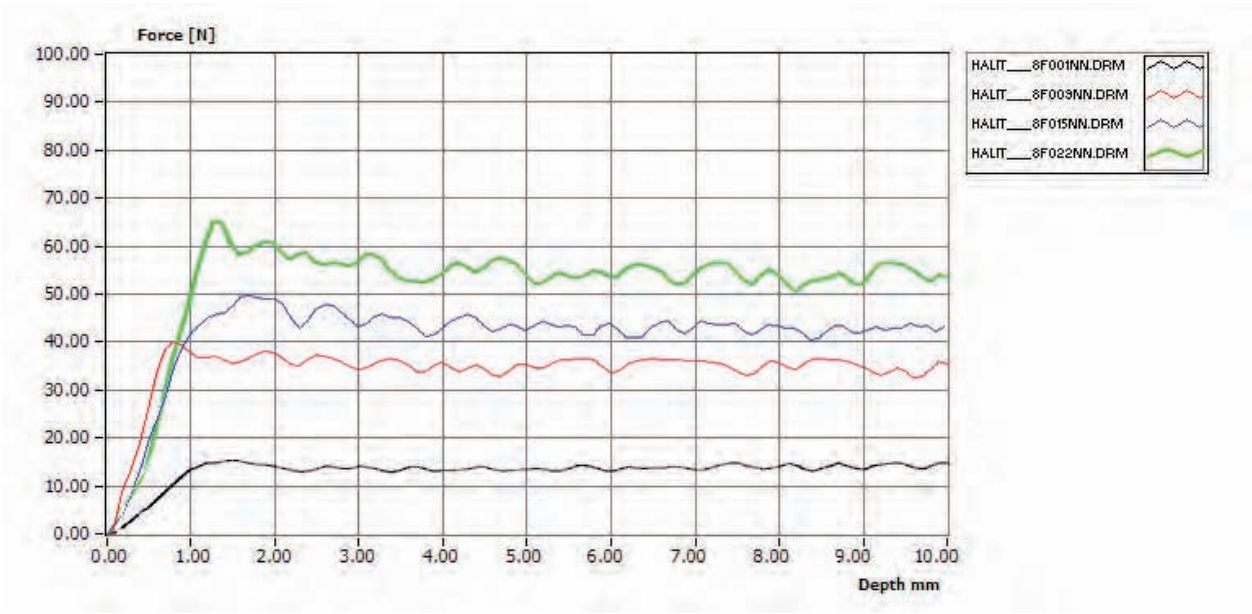
| Ø Values | Consolidation | $\delta_{BZ}$ [N/mm²] | E-–modulus [kN/mm²] |
|---|---|---|---|
| W1 – W6 | untreated | 15,5 | 27,6 |
| W7/W8 | KSE OH | 14,0 | 31,0 |
| W9/W10 | KSE 100 | 17,2 | 30,8 |
| W11/W12 | KSE 300 | 14,8 | 28,9 |

# Bohrhärtemessung/Drilling Resistance

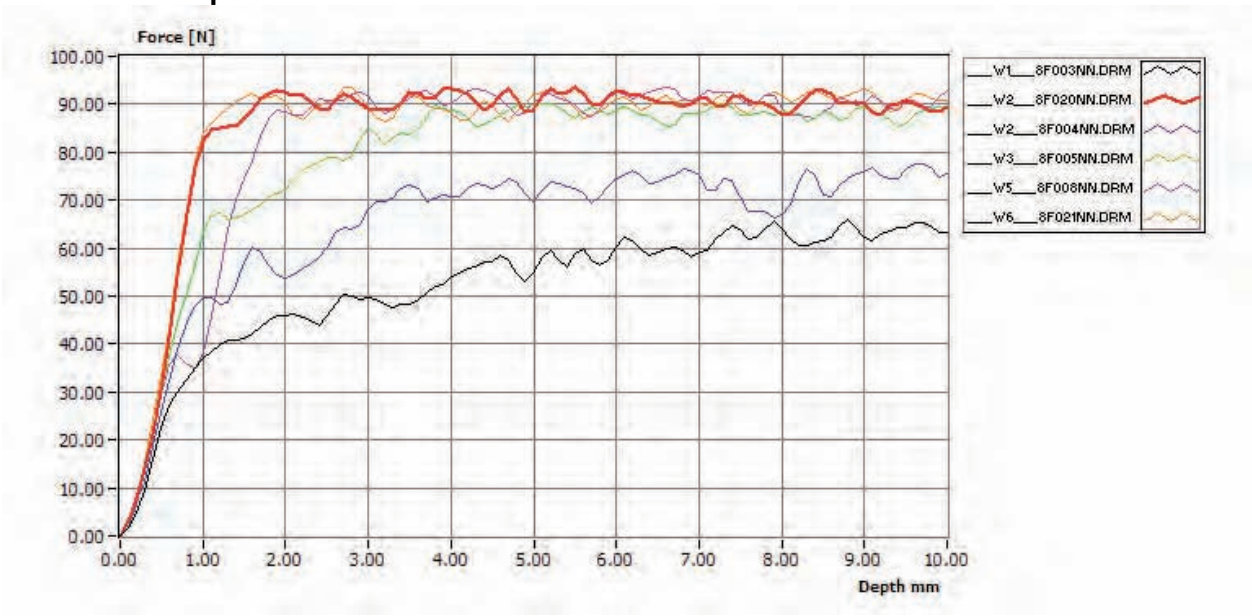
| | | | |
|---|---|---|---|
| Samples: | Jinchuanwan Grotto | Date: | 2.4.2009 |
| Drilling bit: | Diaber Diamondbit 4,8 mm | Bit: | 08 |
| Drilling depth: | 10 mm | | |
| Power feed speed: | 10 mm/min | Rotation speed: | 600 rpm |

| Hole | Sample | Ø Force [N] | Comment |
|---|---|---|---|
| 001 | Halite | 14,86 | |
| 002 | Halite | – | no result |
| 003 | W1 | 57,61 | permanent rise, maximum force after 6 mm |
| 004 | W2 | 70,58 | permanent rise, maximum force after 4 mm |
| 005 | W3 | 88,16 | permanent rise, maximum force after 4 mm |
| 006 | W4 | 88,83 | permanent rise, maximum force after 1,8 mm |
| 007 | W5 | – | no result |
| 008 | W5 | 90,76 | permanent rise, maximum force after 2,5 mm |
| 009 | Halite | 35,08 | |
| 010 | W7 | 90,34 | maximum force after 1 mm |
| 011 | W7 | 87,30 | maximum force after 1,5 mm |
| 012 | W7 | 91.73 | maximum force after 1,5 mm |
| 013 | W9 | 86,30 | maximum force after 1,5 mm |
| 014 | W9 | 92,86 | maximum force after 1,5 mm |
| 015 | Halite | 43,13 | |
| 016 | W9 | 89,98 | Maximum force after 1,5 mm |
| 017 | W12 | 89,35 | maximum force after 1,5 mm |
| 018 | W12 | 88,70 | maximum force after 1,5 mm |
| 019 | W12 | 90,71 | maximum force after 1,3 mm |
| 020 | W12 | 90,74 | maximum force after 2 mm |
| 021 | W6 | 90,33 | maximum force after 1,5 mm |
| 022 | Halite | 56,35 | |
| 023 | W1 | 91,63 | maximum after 1 mm |

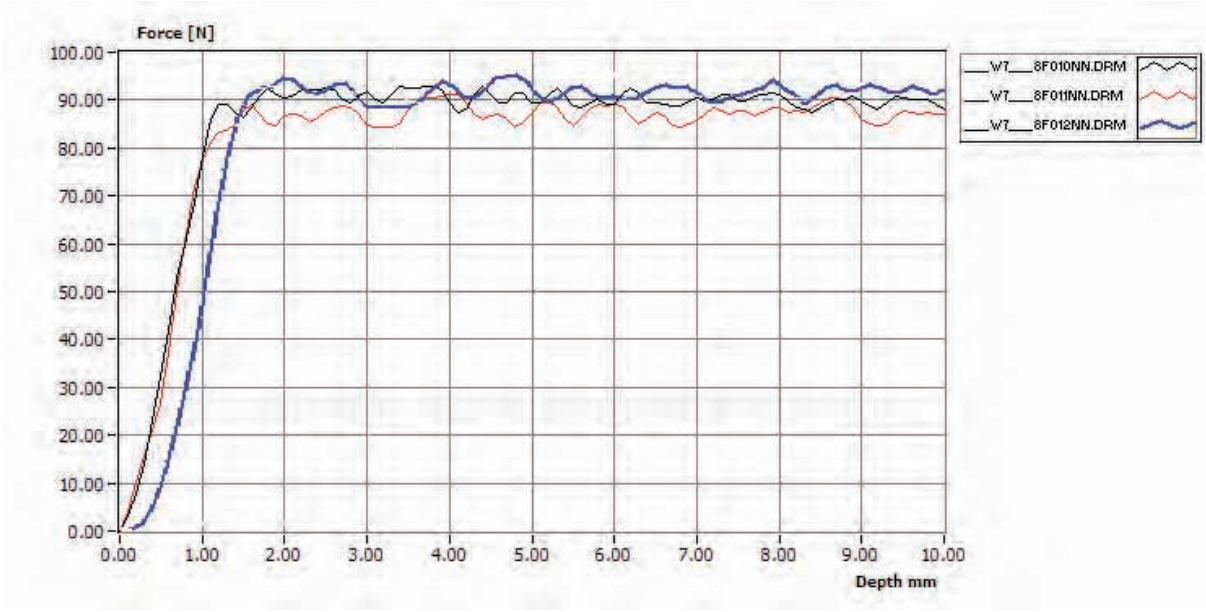
## Halite




## Untreated Samples W1 to W6



**W7**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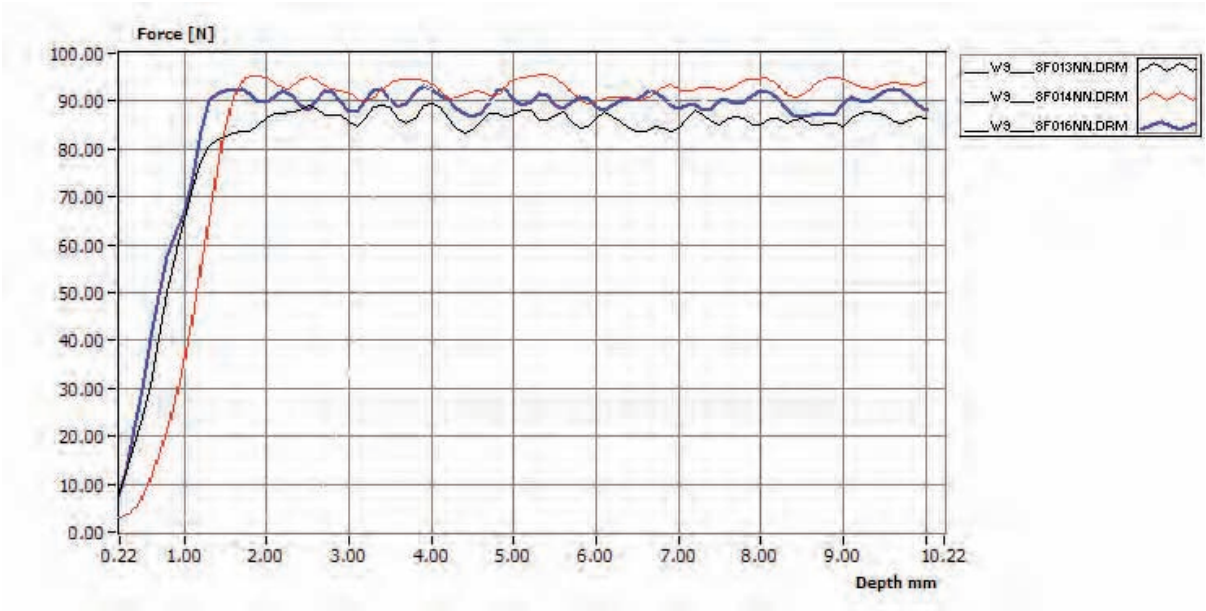
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
Depth mm
W7___8F010NN.DRM
W7___8F011NN.DRM
W7___8F012NN.DRM

**W9**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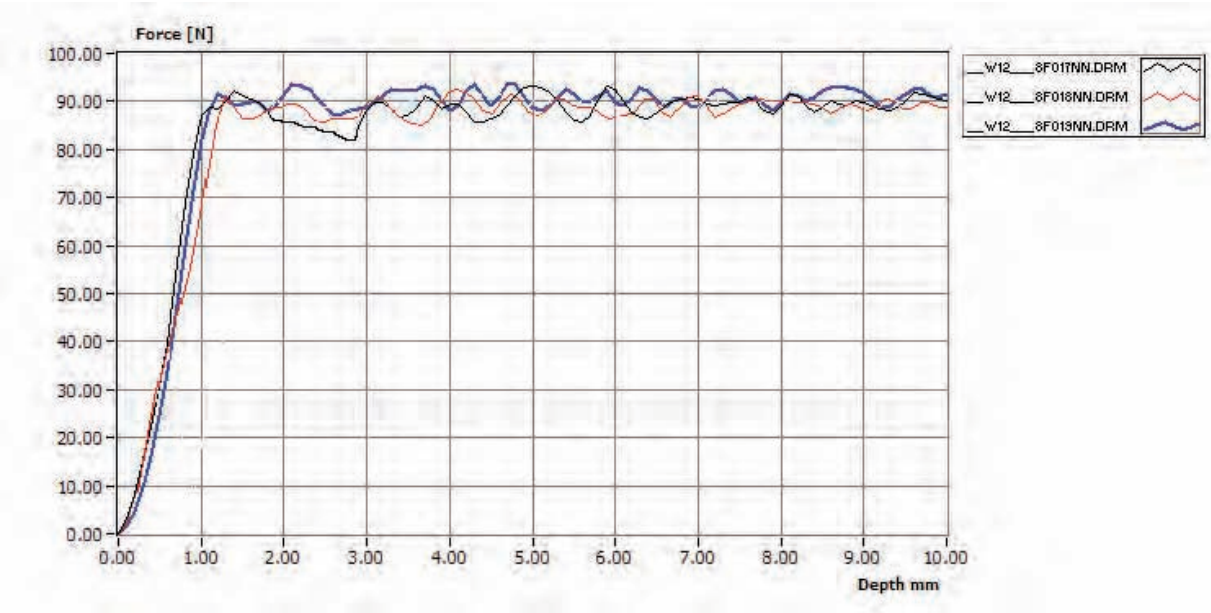
40.00
30.00
20.00
10.00
0.00
0.22
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.22
Depth mm
W9___8F013NN.DRM
W9___8F014NN.DRM
W9___8F016NN.DRM

## W12


Force [N]
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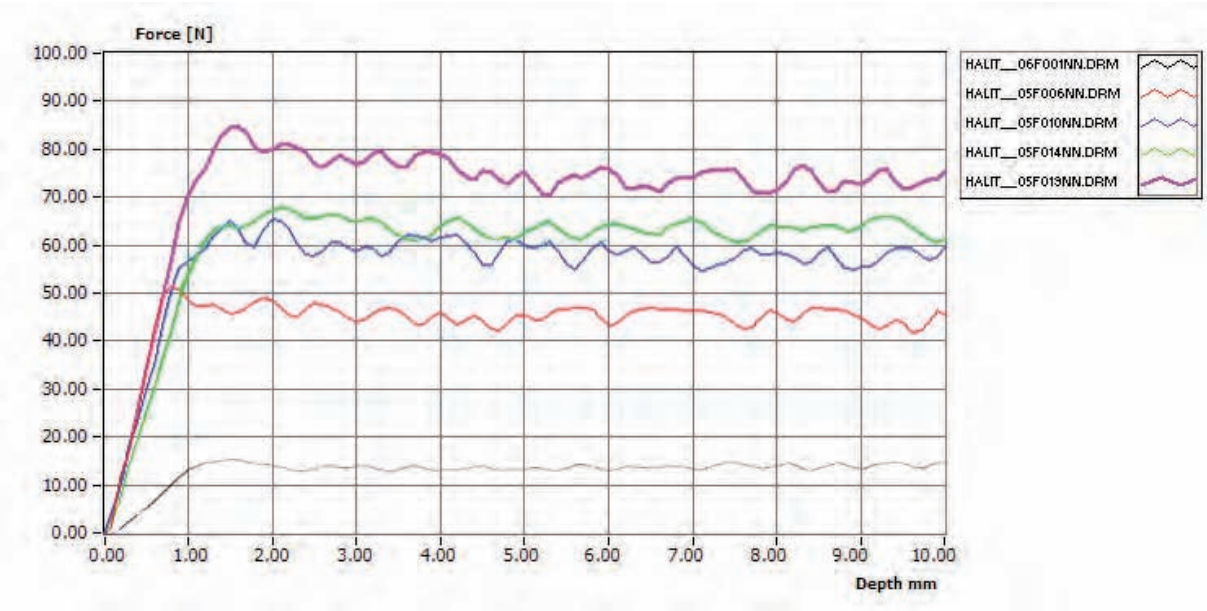
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
Depth mm
_W12___8F017NN.DRM
_W12___8F018NN.DRM
_W12___8F013NN.DRM

# Bohrhärtemessung/Drilling Resistance

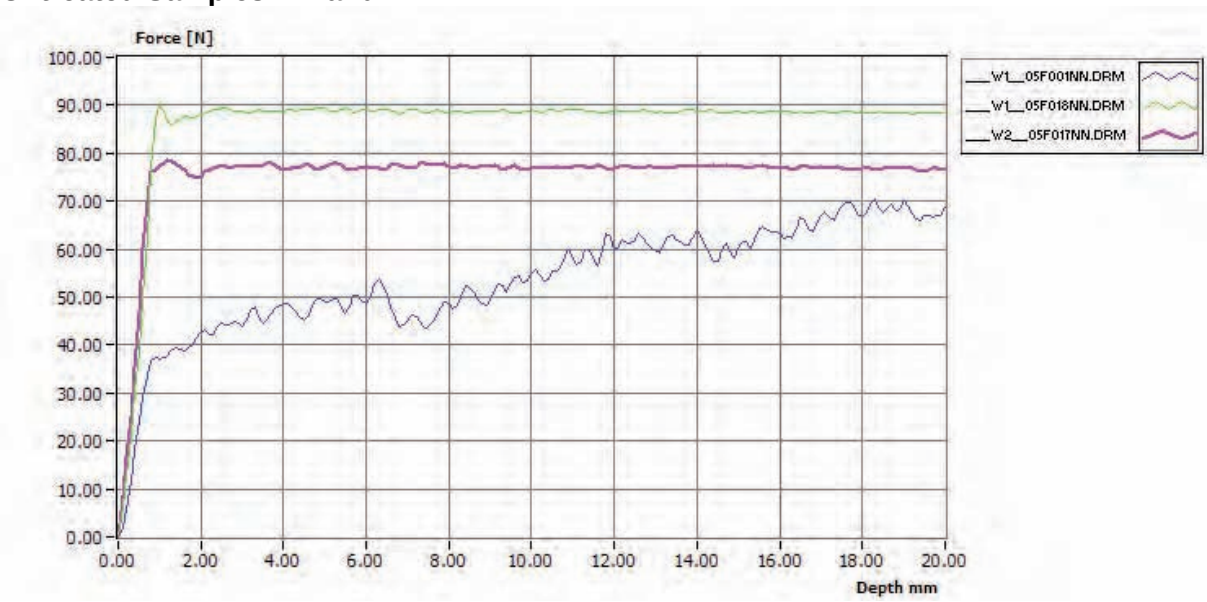
| | | | |
|---|---|---|---|
| Samples: | Jinchuanwan Grotto | Date: | 7.4.2009 |
| Drilling bit: | Diaber Diamondbit 4,8 mm | Bit: | 05 |
| Drilling depth: | 20 mm, Halite 10 mm | | |
| Power feed speed: | 10 mm/min | Rotation speed: | 600 rpm |

| Hole | Sample | Ø Force [N] | Comment |
|---|---|---|---|
| 001 | Halite | 14,88 | |
| 001 | W1 | 50,21 | permanent rise |
| 002 | W1 | 77,41 | fast rise |
| 003 | W8 | 85,60 | maximum force after 1 mm |
| 004 | W8 | 85,19 | maximum force after 1 mm |
| 005 | Halite | | stone broke |
| 006 | Halite | 44,50 | |
| 007 | W10 | 87,41 | maximum force after 1 mm |
| 008 | W10 | 87,01 | maximum force after 1 mm |
| 009 | Halite | (34,99) | stone broke in the first part |
| 010 | Halite | 56,76 | mm maximum force after 1 |
| 011 | W11 | 88,42 | mm maximum force after 1 |
| 012 | W11 | 90,41 | mm maximum force after 1 |
| 013 | W11 | 89,69 | mm maximum force after 1 |
| 014 | Halite | 62,00 | |
| 015 | W7 | 75,44 | mm maximum force after 1 |
| 016 | W7 | 90,61 | mm maximum force after 1 |
| 017 | W2 | 77,05 | mm maximum force after 1 |
| 018 | W1 | 88,74 | mm maximum force after 1 |
| 019 | Halite | 73,25 | |
| 020 | W1 | 89,59 | mm maximum force after 1 |
| 021 | W7 | 88,33 | mm maximum force after 1 |

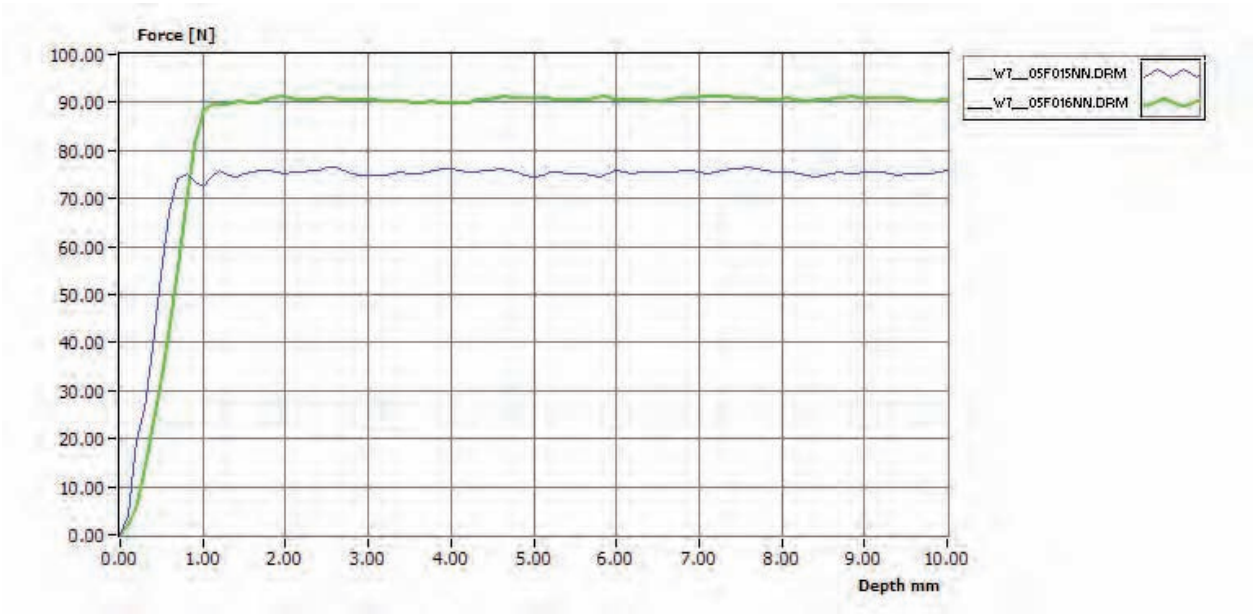
## Halite




## Untreated Samples W1 and W2



## W7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60.00
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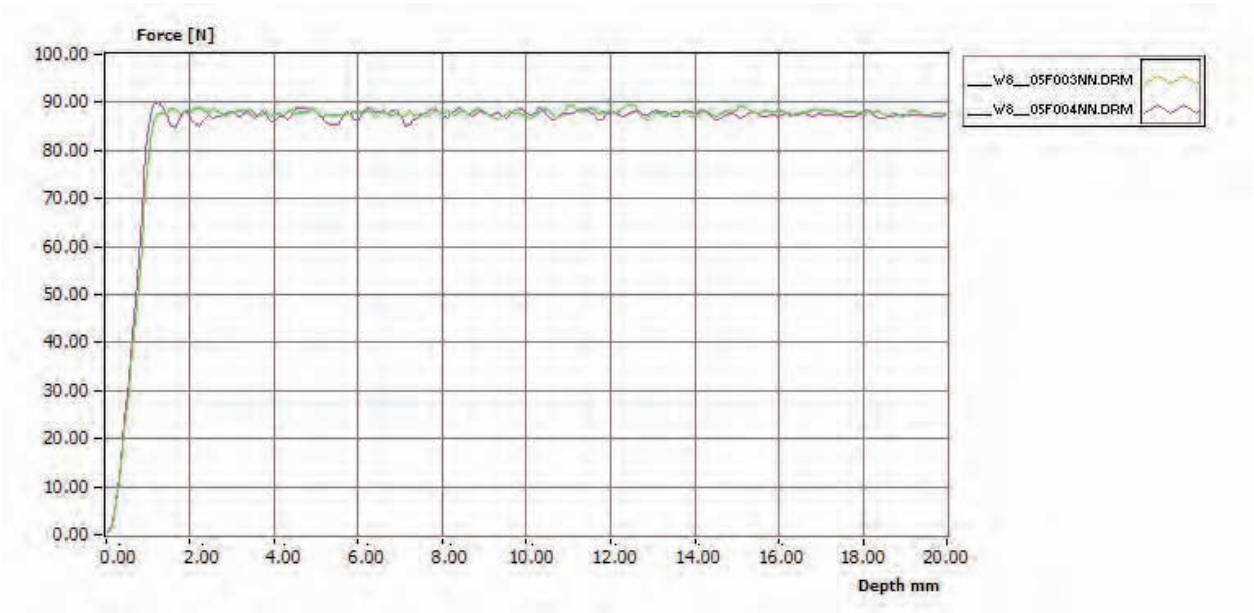
40.00
30.00
20.00
10.00
0.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
Depth mm
__W7__05F015NN.DRM
__W7__05F016NN.DRM

## W8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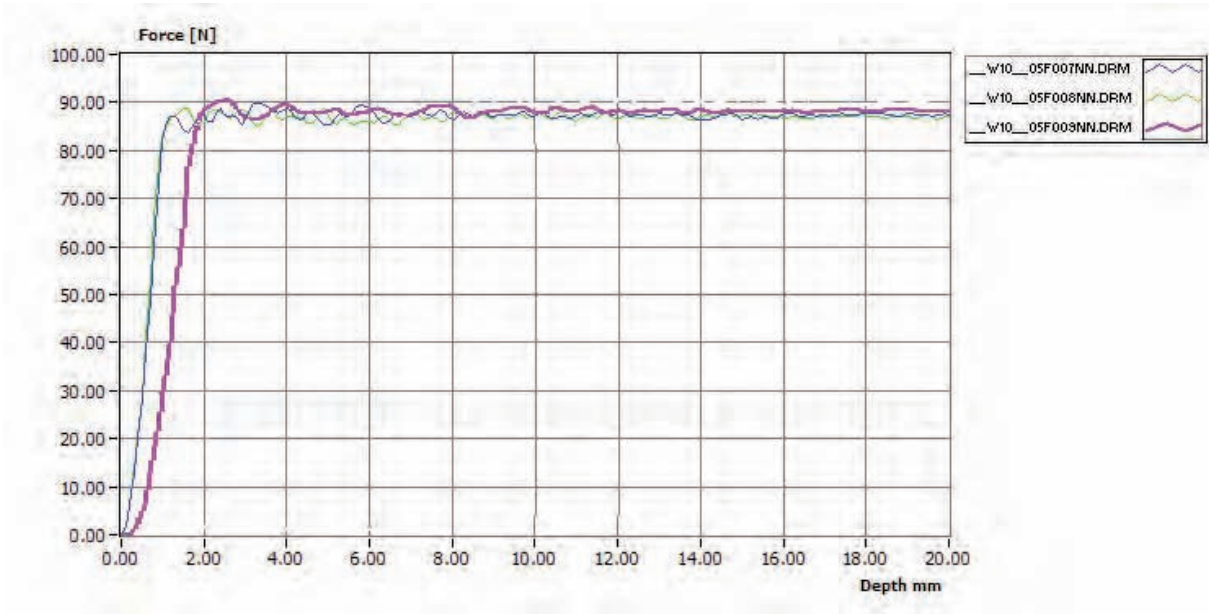
10.00
0.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Depth mm
__W8__05F003NN.DRM
__W8__05F004NN.DRM

## W10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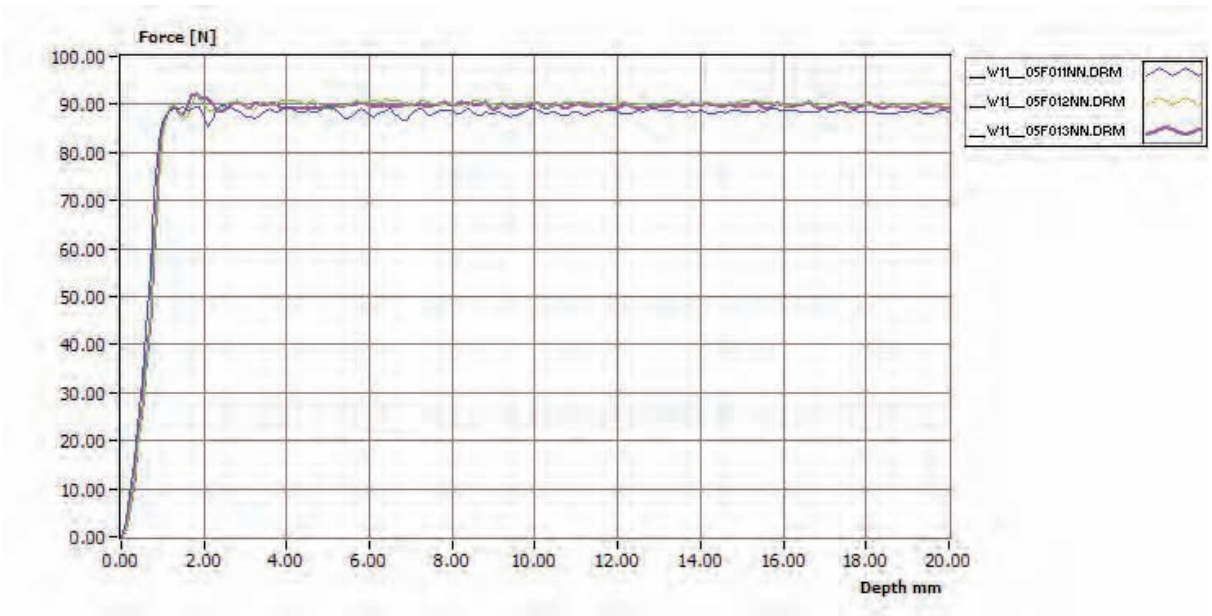
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Depth mm
__W10__05F007NN.DRM
__W10__05F008NN.DRM
__W10__05F009NN.DRM

## W11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20.00
10.00
0.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Depth mm
__W11__05F011NN.DRM
__W11__05F012NN.DRM
__W11__05F013NN.DRM

# Bohrfestigkeit/Drilling Resistance

| | | | |
|---|---|---|---|
| Samples: | Jinchuanwan Grotto | Date: | 16.6.2009 |
| Drilling bit: | Diaber Diamondbit 4,8 mm | Bit: | 04 |
| Drilling depth: | 10 mm | | |
| Power feed speed: | 10 mm/min | Rotation speed: | 600 rpm |

| Hole | Sample | Ø Force [N] | Rise force [%] | Drilled distance |
|---|---|---|---|---|
| 001 | W2 | 38 | 0 % | 10 mm |
| 001 | W2 | 46,5 | 18,3 % | 20 mm |
| 002 | W2 | 55 | 30,9 % | 30 mm |
| 003 | W2 | 60 | 36 % | 40 mm |
| 004 | W2 | 73 | 47,9 % | 46 mm |
| 005 | W2 | 73 | 50,6 % | 56 mm |
| 006 | W2 | 77 | 51,3 % | 72 mm |
| 007 | W2 | 78 | 51,3 % | 82 mm |
| 008 | W2 | 83 | 51,3 % | 92 mm |
| 009 | W2 | 82 | 51,3 % | 102 mm |
| 010 | W2 | 83 | 51,3 % | 112 mm |
| 011 | W2 | 83 | 51,3 % | 122 mm |

After five measurements the diamond bits were blunt.

# Reisebericht China, Jinchuanwan Grotte
# Travelogue China, Jinchuanwan grotto

# Reisebericht China, Jinchuanwan Grotte 6. bis 13.9.2009
# Travelogue China, Jinchuanwan grotto 6. to 13.9.2009

**Martina Klukas (BLfD), Mathias Kocher (TUM)**

| | | | |
|---|---|---|---|
| 6.9.2009 | Abreise | 6.9.2009 | Departure |
| 7.9.2009 | Ankunft in Xi'an, Abendessen mit Direktor Zhang Yinglang, Direktor des Center for the Conservation and Restoration of Cultural Heritage und Herrn Yan Min, der uns während unseres Aufenthalts betreute | 7.9.2009 | Arrival in Xi'an, dinner with Director Zhang Yinglang, Director of the Center for the Conservation and Restoration of Cultural Heritage and Mr. Yan Min, who took care about us during the following days |
| 8.9.2009 | Besichtigung des Center for the Conservation and Rstoration of Cultural Heritage, Vorbereitung des Arbeitsmaterials, Fahrt zur Jinchuanwan Grotte und Begutachtung der Grottenanlage | 8.9.2009 | Visitation of the Center for the Conservation and Restoration of Cultural Heritage, prearrangement of the tools and working material, drive to the Jinchuanwan Grotto and appraisal of the grotto and the environment |
| 9.9.2009 | Jinchuanwan Grotte: Untersuchung der Grottenanlage, Festlegung der Musterflächen, Reinigung und erste Festigung mit Wacker Silres OH 100. Entwicklung eines Maßnahmekonzeptes für die gesamte Anlage | 9.9.2009 | Jinchuanwan Grotto: appraisal of the complex of the grotto, appointing of the consolidation examples, cleaning and first consolidation with Wacker Silres OH 100. Development of a measure concept for the total complex of the grotto |
| 10.9.2009 | Jinchuanwan Grotte: Schadenskartierung der Ostwand, zweiter Auftrag des Festigungsmittels auf beide Musterflächen | 10.9.2009 | Jinchuanwan Grotto: damage mapping of the eastwall, second consolitation of the examples |
| 11.9.2009 | Fahrt nach Lintong, Besuch der Kollegen aus Deutschland<br>Abends: Treffen und abschließende Besprechung mit Direktor Zhang Yinglang und Vizedirektor Ma Tao, Center for the Conservation and Restoration of Cultural Heritage | 11.9.2009 | Drive to Lintong, visit of the colleagues from Germany<br>Evening: Meeting and closing conference with Director Zhang Yinglang and Vize-Director Ma Tao, Center for the Conservation and Restoration of Cultural Heritage |
| 12.9.2009 | Rückreise von Xi'an nach Peking (ungeplanter Aufenthalt in Peking wegen Verspätung des Fluges in Xi'an) | 12.9.2009 | Return journey from Xi'an to Peking, unplanned abidance in Peking (because of fog and lateness in Xi'an) |
| 13.9.2009 | Rückreise nach Deutschland | 13.9.2009 | Return journey to Germany |

## Zustandsbeschreibung

Ein großer Parkplatz direkt an der Staatsstraße und der Weg zum Eingang der Höhle waren neu angelegt. Teile des Weges waren unterspült und vermutlich wegen unzureichender Verdichtung des Bodens wieder eingebrochen (2009). Der Eingangsbereich der Höhle mit der Vormauerung aus Ziegel steht im Kontrast zum neuen Weg und wirkt wenig ästhetisch. Der derzeitige Zustand im Innern der Höhle ist nicht sehr gepflegt. Durch Windverfrachtungen wird der Lehmboden der Umgebung durch die Öffnungen der Vormauerung eingetragen und lagert sich auf den Oberflächen ab. Risse

## First impression of the Grotto

A big parking area and the path to the entrance of the grotto are newly built. Parts of the way were eroded and caved in again (2009), probably because of deficient aggregation of the ground. The foyer of the cave with a wall made of brick stays in contrast to the newer way complex and looks unaesthetic. The condition inside the cave acts untended. By wind shipping, the ground of clay of the environment is charting in the cave by vents in the wall and accumulates on the surface. Cracks in the ceiling and in parts of the walls, as well as big stone ruins inside and outside the grotto,

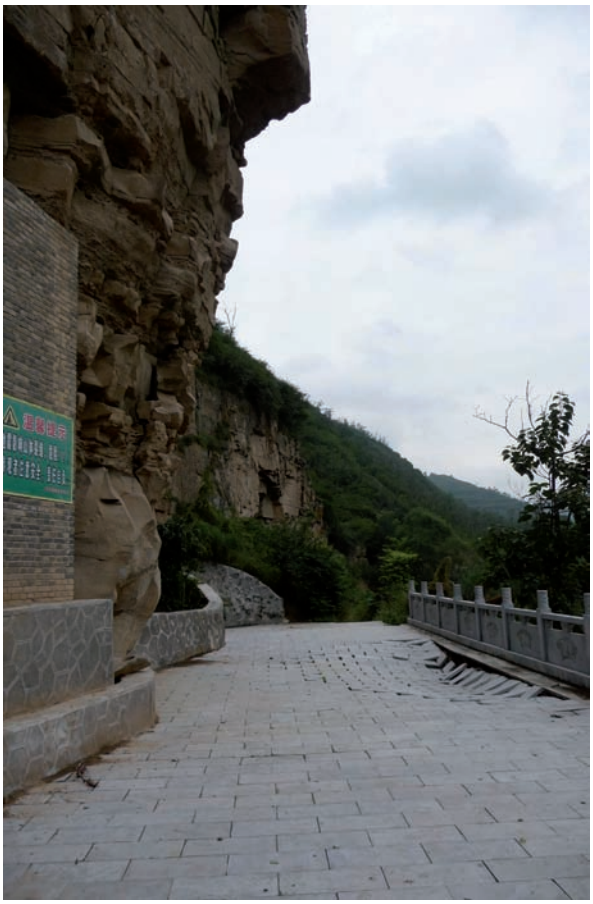


**Abb. 1:** Neue Weganlage vor der Grotte / ***Fig. 1:*** *New path to the entrance of the grotto*

**Abb. 2:** Felsen über der Höhle und Vormauerung aus Ziegel / ***Fig. 2:*** *Stone wall above the grotto and brick wall*

**Abb. 3:** Brunnenanlage im Westen / ***Fig. 3:*** *Water spring system in the west*

**Abb. 4:** Bruchstücke in der Höhle / ***Fig. 4:*** *Ruins in the grotto*

in der Decke und in den Wandflächen sowie große Steinbrocken in- und außerhalb der Höhle zeigen, dass dort aus statischer Sicht Handlungsbedarf besteht. In der Höhle liegen Reste von Figuren: behauene Steine und bemalte Figurenreste aus Lehm.

show that there is need for static measures. Rests of figures of the interior lay in the cave: axed stones and painted figure ruins of clay.

**Untersuchung**

Über eine Leiter konnten höher liegende Zonen, die stärkere Schäden zeigen, genauer betrachtet werden. Im unteren Teil der Höhle zeigen sich Schäden vor allem in Bodennähe. Im oberen Bereich, vorwiegend über dem Wasser führenden Horizont, ist es großflächig schon zum Totalverlust der Inschrift gekommen. Die Oberfläche des Sandsteins löst sich in sehr dünnen Schalen ab. Viele Teile mit gravierenden Schäden zeigen dieses Schadensphänomen auch unter der ursprünglichen, bereits verlorenen Oberfläche. Teilweise sind noch einzelne Schollen mit Inschrift erhalten. Im Bereich des Wasser führenden Horizonts und seitlich des großen Buddhas liegen größere Sandsteinbrocken lose auf einem Absatz. Die Ausbrüche sind teils Folge der Verwitterung des Steins, jedoch auch Folge mechanischer Einwirkung. Im unteren Wandbereich ist der Stein sichtbar abgearbeitet, ebenso die Südost- und die Südwestecke. Wie die Höhle hier ursprünglich gestaltet war könnte anhand älterer Fotografien oder

**Inspection**

A ladder made it possible to inspect the higher parts more precisely, which show grave damage. In the lower partition of the cave defects appear primarily in the ground level, in the higher partition predominantly over the aquiferous horizon of the sandstone, where the surface with the inscription is almost completely destroyed. The surface of the sandstone separates in quite thin peelings. Most of the parts with grave damage show this appearance in layers under the original layer, with already lost surface. In part, there are still obtained fragments of the surface with inscriptions. In the area of the aquiferous horizon and beside the big Buddha sandstone chunks lie loose on a ledge. The breakouts are partly results of the alteration of the stone, nevertheless there are traces of mechanical effect. In the lower wall partition the stone is processed obviously, also the southeast corner and the southwest corner. How the grotto originally was formed in this part could be investigated with the help of historic

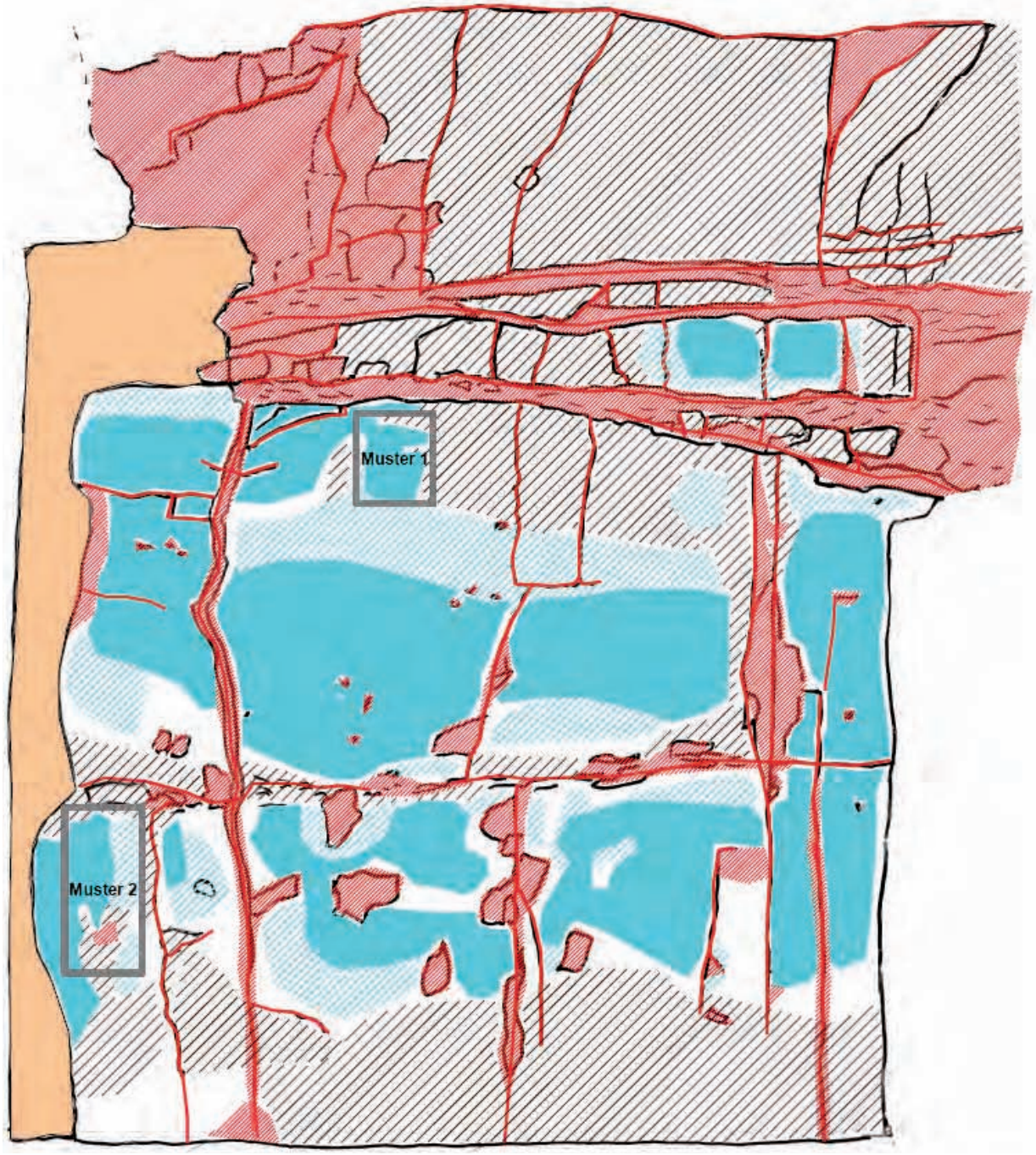
**Abb. 5:** Ostwand 2006 / ***Fig. 5:*** *East wall 2006*

**Abb. 6:** Ostwand 2009 / ***Fig. 6:*** *East wall 2009*

**Abb. 7 (oben):** Übersicht Ostwand der Jinchuanwan Grotte, 2009 / ***Fig. 7 (above):*** *Overview east wall, Jinchuanwan Grotto, 2009*

**Abb. 8 (rechts):** Bestands- und Schadenskartierung der Ostwand der Jinchuanwan Grotte, Provinz Shaanxi, VR China (Martina Klukas und Mathias Kocher, 2009) / ***Fig. 8 (right):*** *Damage mapping east wall, Jinchuanwan Grotto, Province Shaanxi, VR China (Martina Klukas und Mathias Kocher, 2009)*

**Kartierung Ostwand Jinchuanwan Grotte / *Mapping Eastwall Jinchuanwan Grotto***



Zeichnungen geklärt werden, von Interesse wären auch Anhaltspunkte zur ursprünglichen Entwässerung, die in den abgearbeiteten Bereichen der Südost- und Südwestecke zu vermuten ist. Dort haben sich durch Feuchtigkeit Algen angesiedelt, unten Grünalgen, oben ein schwarzer Überzug. Eine archäologische Ausgrabung bis auf das ursprüngliche Bodenniveau könnte Anhaltspunkte zur Entwässerung liefern.

Nach Vergleich älterer Aufnahmen hatten sich die Schäden nicht wesentlich verändert, dennoch sind Schollen gefährdet. An der Ostwand wurde vor Ort eine Bestands- und Schadenskartierung erstellt und die zwei Musterflächen angelegt.

photographs or drawings. The original drainage of the grotto arrangement, which we suspect in the exhausted areas of the southeast and southwest corner, would be very interesting. An archaeological excavation up to the original ground level could deliver other clues.

The comparison of older photographs shows that the damage since 2006 has hardly changed, but several parts are still threatened to fall down. On the east wall, a damage mapping was performed as an overview and the two consolidation examples were applied.

## Musterflächen

Die Musterflächen wurden an der Ostwand angelegt.
**Musterfläche 1:** im oberen Wandbereich 34 x 30 cm
**Musterfläche 2:** im unteren Wandbereich 30 x 70 cm

Die Flächen wurden vor der Festigung vorsichtig mit Pinsel und Skalpell gereinigt und aufliegender Schmutz entfernt. Eine helle, teils verkrustete Schicht lag auf der Oberfläche und wurde vor der Festigung abgenommen. Die XRD-Analyse zeigt, dass es sich dabei um Material des eingetragenen Lehmbodens handelte, der zu Verkrustungen auf der Steinoberfläche führte.

## Examples

The examples were put on the east wall.
**Example 1:** in the upper wall area 34 x 30 cm
**Example 2:** in the lower wall area 30 x 70 cm

The surfaces were cleaned carefully before consolidation treatment by paintbrush, scalpel and barebrush, adhered dirt was removed. A bright partly crusted layer was on the surface. It was taken down before consolidation. The XRD-analysis showed the content of the layer: clay ground, which led to scaling on the stone surface.

**Abb. 9:** Musterfläche 2, gereinigt / ***Fig. 9:*** *Example 2, cleaned*

**Abb. 10:** Musterfläche 2, gefestigt / ***Fig. 10:*** *Example 2, after consolidation*

**Abb. 11:** Übersicht Musterfläche 2, nach der Festigung / ***Fig. 11:*** *Overview, after consolidation*

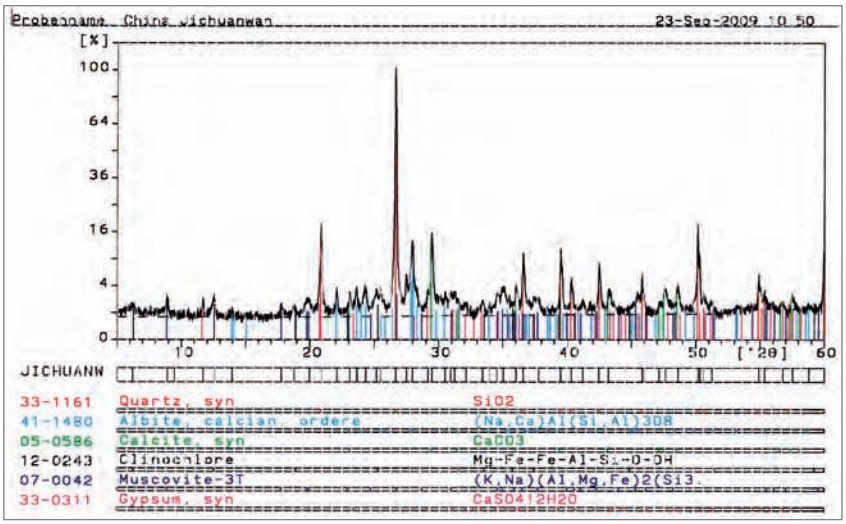



**Abb. 12:** XRD-Aufnahme der Schmutzkruste / ***Fig. 12:*** *XRD-Analysis of the dirt from the stone surface*

Vorgesehen als Material für die Festigung war das Produkt Remmers KSE OH, da es im Labor ein etwas besseres Eindringverhalten als KSE 100 und KSE 300 hatte erkennen lassen. Im Center for the conservation and restoration of cultural heritage stand durch eine Verwechslung dann allerdings nur das Festigungsmittel Wacker Silres BS OH 100 zur Verfügung. Nach Überprüfung der Datenblätter war festzustellen, dass die Produkte ähnlich zusammengesetzt sind und somit Wacker Silres BS OH 100 auch verwendet werden kann.

Auf die Testflächen wurden in zwei Durchgängen an zwei aufeinanderfolgenden Tagen insgesamt ca. 400 ml Steinfestiger aufgebracht. Die Aufnahme des Festigers, durch Sprühen mit einer Niederdruckspritze auf die geschädigte Steinoberfläche, war sehr gut.

Stark gefährdete Bereiche der Musterflächen wurden durch Randkittungen mit Produkten des KSE Modulsystems von Remmers gesichert:

7 Teile Füllstoff A: 4 Teile Füllstoff B wurden mit Quarzsand F36 (ca. 3-fache Menge von Füllstoff A und B) mit KSE 500 zu einer trockenen Kittmasse verarbeitet und die Masse mit Pigmenten (Eisenoxidschwarz, Umbra und Goldocker italienisch) eingefärbt.

Nach der Richtrezeptur von Remmers: Zu je 100 ml Remmers KSE 500 werden folgende Füllstoffe gegeben: KSE-Füllstoff A 70 g und KSE-Füllstoff B 40 g. Die Mischung wird klumpenfrei homogenisiert. In die so hergestellte Masse werden 334 g Remmers Quarzsand F36 gründlich untergerührt.

Nach Auskunft der Firma Remmers sind Remmers KSE OH und Wacker Silres BS OH 100 nahezu identisch: beide sind Kieselsäureesterprodukte ohne hydrophobierende Zusätze. Das Wacker-Produkt kann mit Remmers KSE 300 verglichen werden, allerdings sind die Moleküle etwas anders modifiziert und es enthält keine Lösungsmittelzusätze wie KSE OH. Die Geldabscheidungsrate entspricht der von KSE 300.

Intended for the consolidation was the product Remmers KSE OH, because it had a little better penetration behaviour than KSE 100 and KSE 300 in the laboratory. In the Centre for the conservation and restoration of cultural heritage due to a confusion only the consolidation product Wacker Silres BS OH was available. After examination of the data sheets the products are composed at least similar. Wacker Silres BS OH could also be used.

The examples were treated twice with the consolidation product on two successive days. All in all approx. 400 ml Silres BS OH was absorbed by the stone surface. The product was well absorbed by the injured stone surface by spraying with a low-pressure spraying device.

Endangered areas in the example 2 were treated with putty from the Remmers KSE Modulsystem:

7 parts filler A to 4 parts filler B with quartz sand F36 (1 part filler mixture to 3 parts quartz) were mixed with KSE 500 as a try plaster. For the colouration, pigments were added (ironoxid black, umbra and italian ochre). The mixture was made according to the technical data sheet from Remmers KSE Modulsystem.

Information by Remmers: Remmers KSE OH and Wacker Silres BS OH are nearly identical: Both are silic estres products with no hydrophobic additives. The Wacker product can be compared to Remmers KSE 300, indeed, the molecules are modified a little bit different. The product contains no solvent additions like KSE OH and the gel deposit rate corresponds to that of KSE 300.

**Abb. 13:** Westwand, Inschriften / ***Fig. 13:*** *West wall, inscriptions*

**Abb. 14:** Westwand, gut erhaltener Bereich der Inschrift / ***Fig. 14:*** *West wall, part with inscriptions in good condition*

**Abb. 15:** Westwand, obere Zone / ***Fig. 15:*** *West wall, upper part*

**Abb. 16:** Westwand, Detail obere Zone / ***Fig. 16:*** *West wall, detail upper part*

**Abb. 17:** Südostecke, Grünalgenbewuchs / ***Fig. 17:*** *Southeast corner, with green algae*

**Abb. 18:** Westlicher Teil der Südwand (oben mit schwarzem Algenbewuchs) / ***Fig. 18:*** *South wall, western part with black algae in the upper part of the wall*

**Abb. 19:** Bruchstücke einer Figur (Assistenzbuddha?) / ***Fig. 19:*** *Parts of a figure (assistant buddha?)*

**Abb. 20:** Bruchstücke einer Figur mit Bemalung in der Bodenverfüllung der Höhle begraben / ***Fig. 20:*** *Painted figure ruins in the ground of the cave*

## Geplante Maßnahmen 2010–2013

Eine geologische und hydrologische Kartierung der Höhle und deren Umgebung sowie eine felsmechanische Untersuchung zur Sicherung der Höhle für detaillierte Informationen sind erforderlich.

Wichtig ist, dass im Center for the Conservation and Restoration of Cultural Heritage ein Team benannt wird, das die Restaurierung der Anlage betreut. Der Schwerpunkt sollte nicht nur auf die Konservierung der Inschriften gelegt werden, sondern die gesamte Anlage in das Konservierungskonzept miteinbezogen werden.

Für den Erhalt ist die Entwässerung der Grotte zu verbessern. Vermutlich waren dafür ursprünglich schon Vorkehrungen eingerichtet worden. Bruchstücke der Figuren sind teilweise noch in der Bodenverfüllung erhalten. Daher wäre eine archäologische Freilegung des ursprünglichen Bodenniveaus mit Bergung der noch erhaltenen Figurenteile zu empfehlen.

Nach historischen Aufnahmen und Zeichnungen der Höhle ist in Archiven bzw. in der Umgebung der Grotte zu forschen.

Die felsmechanische Sicherung der instabilen Blöcke ist für den Erhalt der Grotte unabdingbar. Die Reinigung und Sicherung loser Felsstücke und gefährdeter Oberflächenbereiche ist vor der felsmechanischen Sicherung notwendig, da Erschütterungen zu weiteren Schäden führen. Zeitgleich sollte eine Schadenskartierung erstellt werden.

Zum Schutz der Höhle, sowie zur Vermeidung von Schmutzeintrag, ist über eine neue günstigere Eingangslösung (Überdachung) nachzudenken.

Die Entwässerung kann möglicherweise über die Rekonstruktion des ursprünglichen Systems gewährleistet werden.

Vielleicht ist es möglich, die ursprüngliche Figurenausstattung aus den erhaltenen Bruchstücken zu rekonstruieren.

Nach Abschluss der Maßnahmen, ist ein Konzept zur Nutzung und Wartung der Höhle aufzustellen. Wichtiger Bestandteil einer Maßnahme zum Erhalt sind Pflege und Nachkontrolle.

## Planned measures 2010–2013

A geologic and hydrologic mapping of the surroundings of the grotto and a rock-mechanical investigation for the protection of the grotto complex is necessary to get detailed information.

It is important, that the Center for the Conservation and Restoration of Cultural Heritage puts a team together, which will lead the restoration of the grotto. The focus should be laid not only on the conservation of the inscriptions, but be taken up the whole grotto arrangement in the conservation concept.

For the future preservation, the drainage of the grotto should be improved. Presumably, arrangements for the drainage were already made in the original state. The figurative interior of the grotto is preserved partially in the backfill of the ground. Hence, an archaeological exposure of the original ground level with recovery of the still preserved figure parts is recommended. A research of historical photographs and drawings of the grotto in archives or in the surroundings of the grotto should be done.

The rock-mechanical protection is important for the preservation of the grotto. The conservation of the inscriptions should be continued hand in hand with the rock-mechanical work. A cleaning and protection of loose rock pieces and parts with very threatened surface is recommended before the rock-mechanical protection, because vibrations lead to further damages. At the same time a restauratoric damage mapping should be done.

For the protection of the grotto and to minimize dirt input a new favourable entrance is to design.

The drainage can probably guaranteed by the reconstruction of the original drainage system. May be it is possible to reconstruct the original figural interior by the ruins.

After the conservation and restoration measures, a concept for using and attendance is necessary because important parts of a measure are tendance and control after action.

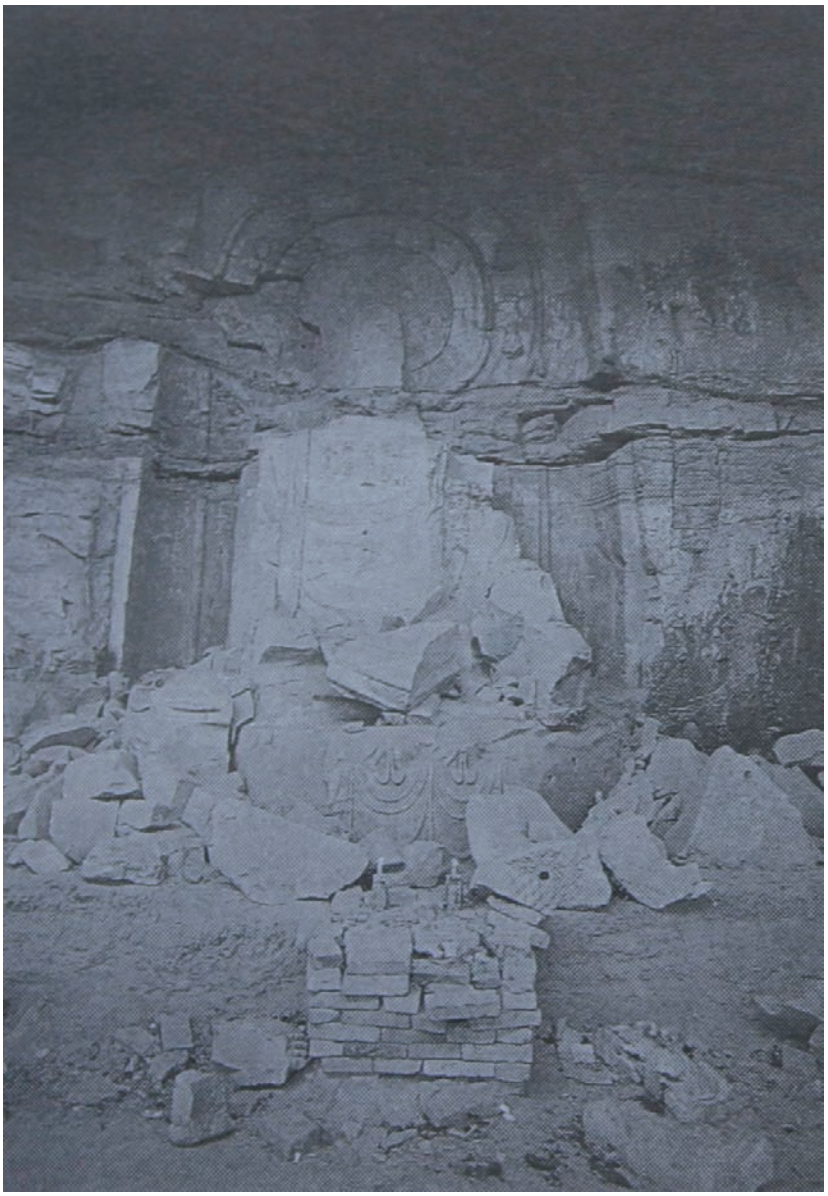


**Abb. 21:** Historische Aufnahme des zerstörten Buddha (Aufnahmedatum unbekannt) / ***Fig. 21:*** *Historic photograph of the destroyed Buddha (date unknown)*

**Maßnahmen**

- Vervollständigen der Voruntersuchungen
- Durchführung der Sicherungsmaßnahmen (felsmechanisch, restauratorisch)
- Restauratorische Bearbeitung der Oberflächen
- Rekonstruktion und Schutzmaßnahmen (Entwässerung, Überdachung, Ausstattung)
- Erstellen eines Wartungs- und Nutzungskonzepts

**Conservation and restoration measures**

- Completion of the investigations
- Rock-mechanical and restoration protection actions
- Conservation and restoration of the stone surface
- Reconstruction and protection of the grotto arrangement (drainage, interior, entrance)
- Concept for use and attendance

**Abb. 22:** Großer Buddha (September 2009) / ***Fig. 22:*** *Big buddha (September 2009)*

Tabelle 1 bietet einen zeitlichen Überblick der Maßnahmen:

**Tabelle 1:** Maßnahmen im zeitlichen Überblick

| | | |
|---|---|---|
| 662–670 | Entstehungszeit der Grotte | |
| … | Rekonstruktion des großen Buddhas | |
| 2005 | Untersuchung, Aufnahme und Transkription der erhaltenen Inschriften | Universität Heidelberg |
| 2006 | Aufnahme der Grottenanlage in die Deutsch-Chinesische Zusammenarbeit | |
| 2006 | Kunstgeschichtliche Einordnung (Prof. Dr. Ledderrose); Übersetzung der Inschriften ins Englische (Zhao Zhou) | Universität Heidelberg |
| 2008 | 3-D-Scan des Innenraumes der Grotte | Univ. Mainz |
| 2008 | Wärmebildaufnahme der Grotte | Center Xi'an |
| 2008 | Entnahme von Gesteinsproben zur Untersuchung | Center Xi'an |
| 2009 | Bestimmung der gesteinsspezifischen Kenndaten und Ermittlung eines geeigneten Festigungsmittels durch Laboranalysen | TUM/BLfD |
| 2009 | Besichtigung und Untersuchung der Grottenanlage | TUM/BLfD |
| | Anlegen einer Musterfläche zur Festigung | |
| | Schadenskartierung der Ostwand und Erarbeitung eines Maßnahmenkonzepts für das weitere Vorgehen | |
| 2009 | Bestimmung des zuständigen Teams, das die Restaurierung der Grottenanlage auf chinesischer Seite leitet | Center Xi'an |
| 2009/10 | Suche nach Archivalien, Zeichnungen und Fotografien der Grotte | Center Xi'an |
| 2009/10 | Geologische und hydrologische Kartierung | Center Xi'an |
| 2009 | Felsmechanische Kartierung gefährdeter Felsbereiche als Vorgabe für die Sicherung | Center Xi'an |
| 2009/10 | Archäologische Ausgrabung der Verfüllung der Grotte: Bergung enthaltener Figurreste, Freilegung des ursprünglichen Bodenniveaus und Untersuchung auf erhaltene Entwässerungssysteme | Center Xi'an |
| 2010 | Einbau eines ebenen provisorischen Bodens (Holz) und Einrüstung der Grotte | Center Xi'an |
| 2010 | Restauratorische Schadenskartierung | TUM/BLfD Center Xi'an |
| 2010 | Reinigung, Vorfestigung und Sicherung gefährdeter Oberflächenbereiche, Verklebung von Schalen | TUM/BLfD Center Xi'an |
| 2010 | Felsmechanische Sicherung der Wände und der Decke | Center Xi'an |
| 2010/2011 | Ausführung der restauratorischen Arbeiten: Nachreinigung, Festigung, Kitten und Hinterfüllen von Schalen und abschuppenden Bereichen, Schlämmen von Bereichen mit verlorener offenporiger Oberfläche zur Beruhigung des Gesamtbildes und zur Verringerung der Oberfläche (Verschmutzung), evtl. Ergänzungen | TUM/BLfD Center Xi'an |
| 2011/12 | Rekonstruktion des Entwässerungssystems und der Figurenausstattung | Center Xi'an |
| 2011/12 | Konzept für die Nutzung und Wartung der Grottenanlage (neue Eingangslösung, Überdachung der Grotte, Zugang für Besucher) | Center Xi'an |

Legende: Center Xi'an: Center for the Conservation and Restoration of Cultural Heritage, Beijing; TUM: Technische Universität München, Lehrstuhl für Restaurierung, Konservierung und Kunsttechnologie; BLfD: Bayerisches Landesamt für Denkmalpflege, München

Table 1 shows the measures in a timetable:

***Table 1:*** *Measures in a temporal overview*

| | | |
|---|---|---|
| 662–670 | Time of origin of the Jinchuanwan grotto | |
| … | Reconstruction of the big Buddha | |
| 2005 | Investigation of the inscriptions and transcription | Universität Heidelberg |
| 2006 | The grotto became part of the Chinese-German cooperation | |
| 2006 | Art historical classification (Prof. Dr. Ledderrpse); English translation of the inscription (Zhao Zhou) | Universität Heidelberg |
| 2008 | 3-D-scan of the grotto | Univ. Mainz |
| 2008 | Infrared photography of the grotto | Center Xi'an |
| 2008 | Preparation of stone samples for examination | Center Xi'an |
| 2009 | Collection of the stone features, laboratory analysis to find a fitting consolidation material | TUM/BLfD |
| 2009 | Visitation and examination of the grotto arrangement | TUM/BLfD |
| | Examples for consolidation | |
| | Damage mapping east wall and plan an action concept for the following measures | |
| 2009 | Build-up of a Chinese team, which leads the restoration of the grotto arrangement | Center Xi'an |
| 2009/10 | Search for historic paintings and photographs in archives | Center Xi'an |
| 2009/10 | Geologic and hydrologic mapping of the surroundings of the grotto | Center Xi'an |
| 2009 | Rock-mechanical mapping as parameters for protection | Center Xi'an |
| 2009/10 | Archaeological exposure of the original ground: save figure ruins, get the original ground and examination for historic drainage systems | Center Xi'an |
| 2010 | Framework on a temporary floor | Center Xi'an |
| 2010 | Restoratoric damage mapping | TUM/BLfD Center Xi'an |
| 2010 | Cleaning, preconsolidation and protection of parts with threatened surface | TUM/BLfD Center Xi'an |
| 2010 | Rock-mechanical protection of the walls and the ceiling | Center Xi'an |
| 2010/11 | Restoratoric works: Postcleaning, consolidation, to putty and backfill scaling areas, muds of parts with lost splintered surface to reassurance of the general view and for the reduction of the surface (soiling), possibly reconstructions | TUM/BLfD Center Xi'an |
| 2011/12 | Reconstruction of the historical drainage system and the figural interior | Center Xi'an |
| 2011/12 | Concept for using and attendance. New entrance solution | Center Xi'an |

Key: Center Xi'an: Center for the Conservation and Restoration of Cultural Heritage, Beijing; TUM: Technische Universität München, Lehrstuhl für Restaurierung, Konservierung und Kunsttechnologie; BLfD: Bayerisches Landesamt für Denkmalpflege, München