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This booklet includes two parts: Geology and Geography, it is prepared for a scientific excursion after the International Symposium on the Karakorum and Kunlun Mountains which is to be hold in June of 1992 in Kashgar, Xinjiang, CHINA. The booklet mainly offers a brief introduction in geological and geographical fields along the scientific excursion rout from Kashgar to Kunjirap Pass. These Scientific results and data may be useful for the scholars of geosciences and biosciences.

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Preface

This booklet offers a brief scientific introduction to the Karakorum and Kunlun Mountains, including two parts: I. Geology and II. Geography. It is originally prepared for a scientific excursion after the International Symposium on the Karakorum and Kunlun Mountains (ISKKM) which is to be held in June of 1992 in Kashgar, Xinjiang Uygur Autonomous Region, China. The post-symposium excursion is planned to start off from Kashgar, along the Sino-Pakistan highway southwardly through southwestern margin of Tarim Basin, West Kunlun, and eastern flank of Pamir, terminating at Kunjirap Pass which is located at the boundary between China and Pakistan. The total travel distance is about 450km (Figure 1).

The Karakorum and Kunlun Mts. are an attraction of complicated geological history and unique characteristics of physical environment and biota. The first and earliest expeditions to the region were made by a number of world famous explorers and scientists, such as S.Hedin, A.Henning, R.Norin, H.de Terra, A.Desio, Liu Shen'e, H.A.Belyaevsky and others. Their fruitful and remarkable work pioneered scientific study on the Karakorum and Kunlun Mts., and will be forever respected by all geologists and geographers all over the world.

Since the founding of the P.R.China, the Chinese government has consistently supported the scientific investigation on natural environments and resources in the region. Most of the work on mineral resources and regional geological survey were carried out by the Xinjiang Bureau of Geology and Mineral Resources, the Ministry of Geology and Mineral Resources before the 1970s. Several scientific expeditions and mountain climbings in the region concerned took place between 1956 and 1976. They are: 1959, mountain climbing and expeditions in Mt. Muztagata; 1958-1959, Xinjiang Integrated Scientific Expedition, Chinese Academy of Sciences (CAS) to Karakorum and Kunlun Mts.; 1960, Xinjiang Integrated Scientific Expedition, CAS to West Tibet and the Kunlun Mts.; and 1976, the Integrated Scientific Expedition to Qinghai-Xizang Plateau and the Ngari Region. Since the 1980s, the scientific expeditions and mountain

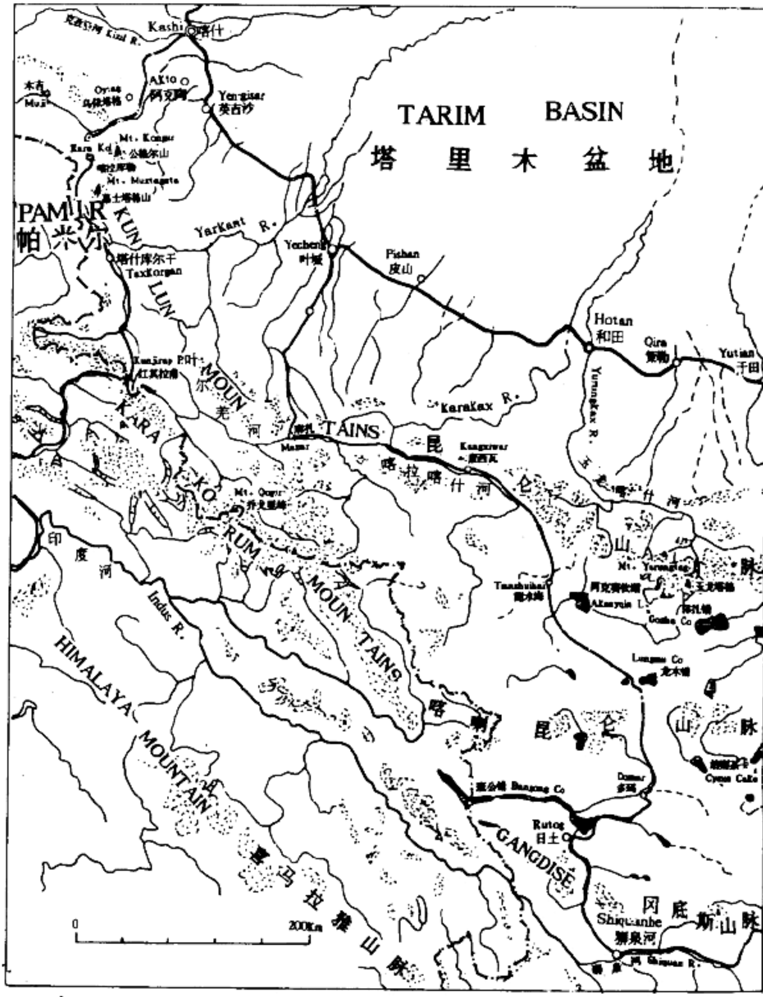

Figure 1 A sketch map of West Kunlun and Karakorum Mountains area

图 1 西昆仑—喀喇昆仑地区略图

climbings in the Karakorum and Kunlun Mountains have been extremely active, for instance, the expedition to the region organized by the Chinese Academy of Geosciences in 1980-1982, the expedition to the Karakorum and Qiangtang by the Tibetan Geological Team from the Ministry of Geology and Mineral Resources in 1980-1984; Sino-German, and Sino-Japan expeditions to West Kunlun in 1986-1988; Italian expedition to Qogir in 1988 and mountain climbings and expeditions in Muztagata, Crown and Qogir held by Japan and Great Britain recently. From 1987 to 1991, supported by both the Chinese Academy of Sciences (CAS) and National Natural Science Foundation of China (NSFC), a multi-disciplinary scientific expedition was conducted in Karakorum and Kunlun mountain regions by Integrated Scientific Expedition to Qinghai-Xizang Plateau, Chinese Academy of Sciences (ISEQP, CAS). This expedition was joined in 1989 and 1990 by Centre National de La Recherche Scientifique (CNRS) and Institut National des Sciences del'unirey (INSU), France, mainly in the Karakorum and West Kunlun Ranges, during which two scientific traverses of Yecheng to Shiquanhe and Kashgar to Kunjirap were completed on a systematic study of geological history, mechanisms of plate collision, neotectonics of the region, environmental changes, physical regional differentiations and characteristics of the botanical ecology and biology. Several members of ISEQP, CAS have also carried out a Sino-Pakistan expedition to the southern flanks of Karakorum range from Kunjirap Pass to Besham, a total distance of 600km. The Integrated Scientific Expedition to the Hoh Xil Region of the Qinghai Province was carried out for a research project of establishment of the nature reserves to protect landscape and wildlifes on the Plateau from 1989-1990. Meanwhile, geological maps of 1:500,000 and 1:1,000,000 and tectonic map of 1:2,000,000 have been compiled by Xinjiang Bureau of Geology and Mineral Resources.

The International Symposium on Karakorum and Kunlun Mountains initiated by CAS, NSFC, CNRS and INSU is intending to provide a solid platform, on which geoscientists from different countries can discuss and exchange their research results of different cooperative study. This guidebook is merely to provide primary information on general geology and geography. It is only our hope that the guidebook summarizes the good representative background data for discussion and thinking on many problems which will come across during the field excursion and in future works. This guidebook is written up based on the results of expeditions carried out in past. A detailed study and arrangement of the localities described in this book has been completed in August-September, 1991.

CONTENTS

1. Introduction

The Tibetan Plateau has been named the third pole of the Earth. It is characterized by the mergence of many huge Asian mountain ranges with high elevation. It is at the origin of many major rivers of Asia. It is also a unique geological object. It is the highest, largest and most puzzling plateau on the planetary with many of its terranes once part of the Tethys ocean. A key area to the Earth sciences, it has become an international "hotspot" and attracts many scientists worldwide.

The geotraverse from Kashgar to Kunjirap is located along the juxtposition of the westernmost margin of the Tibetan Plateau and the eastern margin of the Pamir range with an elevation varying from 2,500 to 4,700m. It passes through the West Kunlun and northern flank of the Karakorum (Figure A-1). Earth movement has kept this region active since early geological times, which makes it an excellent locality to study the evolution of the Tibetan Plateau and Tethys ocean, as well as the structure of the lithosphere and plate tectonics. The geology along the traverse has crustal features similar to those of Tibet, which has a multilayered crust of double thickness (60-70km). There are at least two low velocity zones in the crust. The Tibetan Plateau is formed of different blocks separated by several suture zones whose age becomes younger to the south (Figure A-2). It is therefore considered that the Tibetan Plateau was formed by a continuous northward accretion of continental fragments that rifted away from Gondwanaland to become attached to the Eurasia continent.

2. Fundamental Geology

The geotraverse from Kashgar to the Kunjirap Pass extends from the Tarim Basin to the northern flank of Karakorum range. From north to south, it crosses a number of different blocks and tectonic zones: the North Kunlun Block (NKB), the Oytag-Kudi Suture Zone (OKSZ), the Central Kunlun Block (CKB), the South Kunlun Suture Zone (SKSZ), the Taxkorgan - Tianshuihai Block (TTB), the

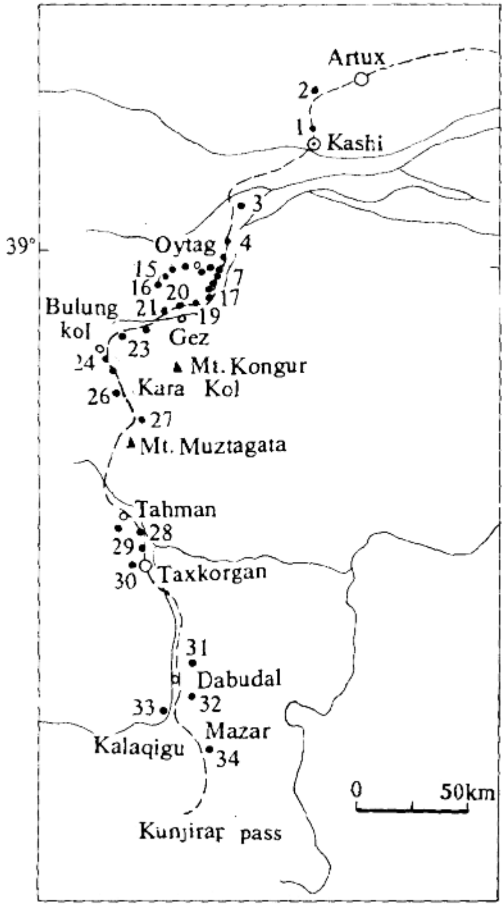

Figure A-1 Map of expedition traverse and visiting locaion

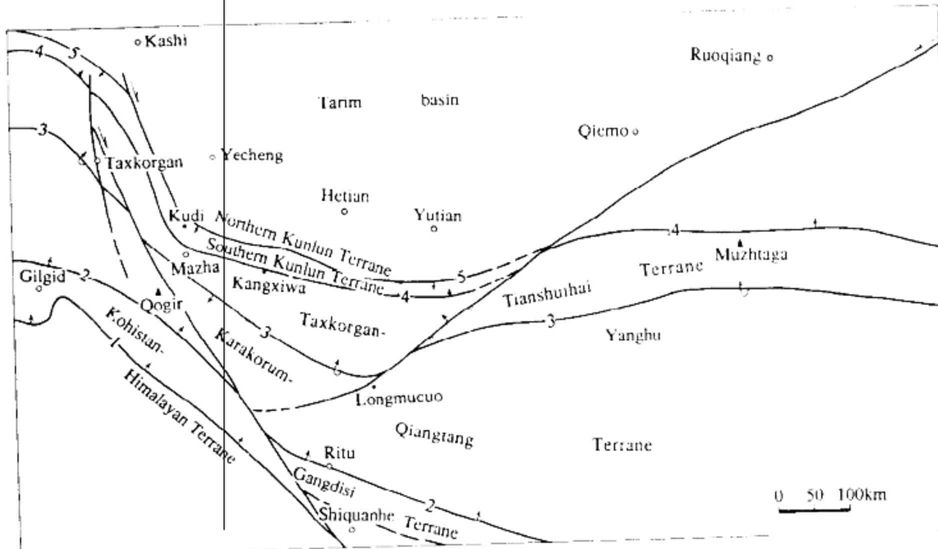

Figure A-2 Map of tectonic divition in the Kunlun-Karakorum Mountain ranges
1-Indus-Yaluzangbu suture zone 2-Bangonghu suture zone 3-Hongshanhu-Qiaoertianshan suture zone 4-Mazha-Kangxiwa suture zone 5-Kudi-Subashi suture zone

Taaxi-Qiaoertianshan- Hongshanhu Suture Zone (TQHSZ), and the Karakorum Block (KKB). If one goes further south, the following geological elements will come across: the Karakorum Suture Zone (MKT), which is probably an equivalent of the Bangong Co Suture Zone in Tibet, the Kohistan Island-arc which is equivalent to the Gandise or Lhasa block in the east, the Indus Suture Zone (Yarlungzangbo Suture Zone in the east), and the Western Himalayas (Table A-1). In the section, many of the blocks and sutures have been reduced and swelled by crustal shortening and strike-slip shearing. The geological elements on the Chinese side of the area are briefly described in the following (Figure A-3)*:

2.1 The North Kunlun Block (NKB)

It is bounded by the Tarim Basin to the north and the Oytag-Kudi Suture Zone (OKSZ) to the south. The basement rocks outcrops in the region are mainly middle and late Proterozoic gneisses and migmatite. A gneissic granite intruded into the basement rocks in Akartze Pass, south of Yecheng yields an age of 2,100 Ma by zircon U-Pb method. Above these rocks are Sinian intercalations of stromatolite marbles and greenschists. The compositions of the greenschist show that it is originally oceanic tholeiite. Late Devonian red molasse conglomerates unconformably overlie these rocks. The clastic Devonian sediments became finer upwards and transitional to

* Figure A-3: 1-Quaternary sandy and pebble. 2-Neogene red sandstone. 3-Eogene red sandstone. 4-Cretaceous red sandstone intercalated limestone. 5-Coal-containing shale in the Kunlun region, limestone in the Karakorum region. 6-Triassic limestone and sandstone in the Karakorum, slate and sandstone in the Tianshuihai region. 8-limestone and shale intercalated volcanic in the Kunlun and Karakorum, Phyllite in the other. 11-lower is conglomerate, upper is limestone in the Karakorum, limestone in the Qiangtang. 12-13-phyllite. 14-limestone and greenschists. 15-gneiss. 16-21-granite (6-Himalayan period, 5-Indo-Sinian and Yeshanian period, 4-Hercynian period, 3-Caledonian period) 22--26-granodiorite. 27-28-diorite. 29-alkaline rocks. 30-*Ophiolite*. 31-medium volcanics. 32-mafic volcanics. 33-gneiss. 34-Thrust fault. 35-strike-slip fault. 36-fault. 37-unconformable.

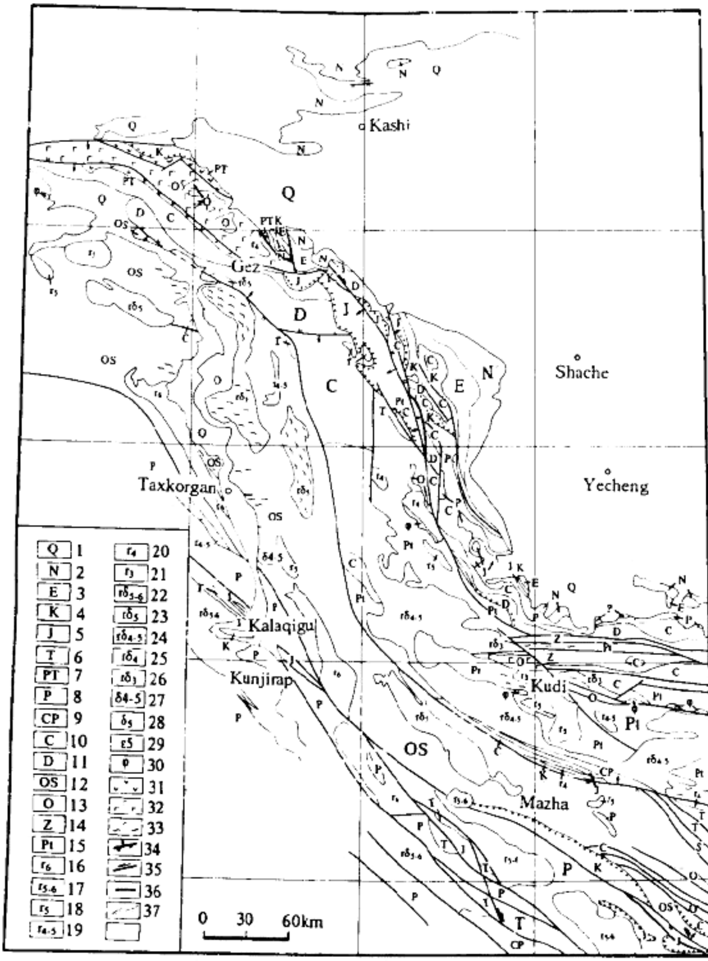

Figure A-3 Geological map of Kunlun-Karakorum Mountain Ranges

Table A-1 Table of regional stratigraphics

Time \ Formation \ Area	Kunlun region	Tianshuihai region	Qiangtang region	Lhasa region
Cenozoic	Red beds	Red beds		Red beds
Cretaceous		Limestone Red beds	Limestone Red beds	Volcanics Limestone Red beds
Jurassic	Shale intercalated with coal sandstone		Limestone shale, sandstone	Limestone shale
Triassic	Shale, limestone sandstone, volcanic	Slate sandstone	Limestone shale sandstone	Limestone shale, phyllite
Late Paleozoic	Limestone shale sandstone conglomerate Volcanic	Phyllite intercalated with volcanic and limestone		Limestone shale sandstone
Early Paleozoic	Ordovician: Phyllite limestone Volcanic		Pre-Devonian: Quartz schists mica schists slate sandstone phyllite	
Sinian	Greenschists intercalated with limestone	Phyllite Volcanic		Gneiss amphibolite
Presinian	Gneiss amphibolite migmatite			

carbonate, continuously into Carboniferous and Permian. Terrestrial coal-containing clastic sediments appear in the Jurassic, representing a post-orogenic mountain foreland or an intermontane basin type sedimentation. Sedimentation of the Cretaceous red sandstone and conglomerates with a small amount of limestone in the bottom continued with sandstones and shales into the early Pleistocene. Middle Pleistocene terraces are unconformable on top of the previous rocks. It is suspected that there is a major buried blind fault separating the Kunlun block from the Tarim Basin (i.e. the Kunlun block was overthrusted on the Tarim Basin), although this boundary is not apparent at the surface (Figure A-4).

2.2 The Oytag-Kudi Suture Zone (OKSZ)

It separates the Central Kunlun Block (CKB) from the North

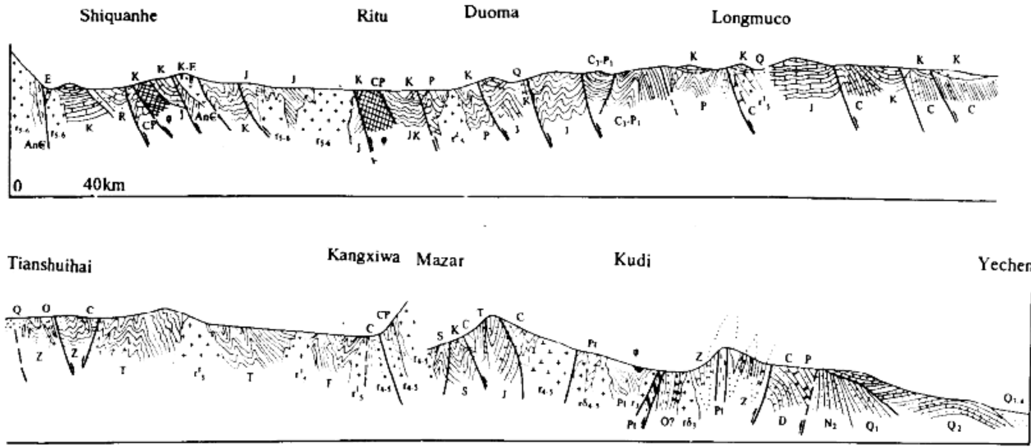

Figure A-4 Geological profile of Geotraverse from Yecheng to Shiquanhe

Q_{4-3}-recent deposit Q_2-sandy, pebble Q_1-conglomerate and sandstone N_2-sandstone E-red conglomerate R-red conglomerate K-E-medium and mafic volcanic K-red sandstone and limestone JK-flysch J-limestone T– slate C_3-P_1-Gondwana facies sediments P-limestone and schists C-limestone and phyllite S-phyllite O-phyllite, volcanic and limestone Z-marble and greenschists Pt-gneiss AnЄ-gneiss and schists r_{5-6}-Himalaya-Yeshanian granite r^2_5-Yeshanian granite r^1_5-Indosinian granite r_{4-5}-Indosinian-Hercynian granite r_3-Caledonian granite $r\delta_{4-5}$-Indosinian-Hercynian granodiorite $r\delta_3$-Caledonian granodiorite φ-Ophiolite

Kunlun Block (NKB). The rocks in this suture zone are ultramafic rocks, pillow lavas, basalts, swarms of diabase dykes and siliceous flyschs. The compositions of the pillow lava represent a matured oceanic ridge type tholeiite, and the petrological, mineralogical and geochemical features of those siliceous flyschs are quite similar to the underlying oceanic crust, which can be treated as a deep oceanic ophiolitic turbidite (Tables A-2,A-3; Figures A-5,A-6). Hence, it is interpreted as a disrupted ophiolite belt. The age of this ophiolite suite is controversial. There are some intermediate and acidic intrusions into the pillow lavas and basic volcanic rocks north of Kudi, south of Akartze Pass. A diorite in the north is dated 458 Ma by Rb-Sr isochron dating, 480 Ma by $^{40}Ar/^{39}Ar$ and 517 Ma by K-Ar whole rock method. A granite in the south is dated 384 Ma by $^{40}Ar/^{39}Ar$ and 423 Ma by Rb-Sr isochron method. A pegmatitic amphibolitic dyke intruded into the Kudi ultramafic rocks has been dated 816 Ma by Rb-Sr isochron method. The model age of pillow lavas is 600-900 Ma in Yixikgou (Table A-4). According to all these data we may consider the OKSZ was formed between the Sinian and the Early Paleozoic time.

2.3 The Central Kunlun Block (CKB)

The Central Kunlun Block (CKB) is bounded by the Oytag-Kudi Suture Zone (OKSZ) to the north and the South Kunlun Suture Zone (SKSZ) to the south. The rocks in this block are mainly amphibolitic plagio-gneiss, migmatitic gneiss and amphibolites, into which acidic and basic dykes were intruded. These dykes also experienced amphibolitic metamorphism. Late Paleozoic sediments, continuous from Devonian to Permian unconformably overlie these rocks. Terrestrial red molasse in the lower part of Devonian grades upwards into carbonate, intercalated with intermediate to intermediate-basic volcanics of Late Carboniferous to Permian age, such as andesites, andesitic basalts etc., indicating a calc-alkaline island-arc type in Gez and Xiana Bridge (Figure A-7). South of this block there are Triassic sand-shales within which one can often

Table A-2 Average Chemical Composition of the Ophiolitic Graywackes as Compared with Graywacks and Lower Part Bedback and Correlation Basic Volcanic Rocks

Chemical Composition	Yixikgou Ophiolitic sandstone (1) sd-430	Yixikgou Ophiolitic Sandstone (2) sd-439	Yixikgou Ophiolitic Sandstone average 2	Yixikgou Basic Volcanic average 7	Rikazi-Bailan Ophiolitic Sandstone average 18	Rikazi-Bailan Dykes average 22	Oceanic tholeiite average 161	Developing arc basalt average	General Sandstone average 61
SiO_2	50.48	51.37	50.93	49.33	55.88	51.55	49.80	58.78	68.92
TiO_2	1.01	1.32	1.17	1.29	0.72	0.51	1.80	0.84	0.51
Al_2O_3	16.12	16.79	16.46	13.55	18.10	13.19	15.20	15.54	13.13
Fe_2O_3	1.70	6.31	4.01	5.55	4.02	2.56	2.40	2.63	0.86
FeO	6.07	4.60	5.34	9.46	7.71	8.08	8.00	5.04	3.68
MnO	0.11	0.13	0.12	0.19	0.24	0.20	0.17	0.11	0.09
CaO	8.37	3.84	6.11	6.38	5.37	8.50	10.90	8.02	2.00
MgO	6.08	4.05	5.07	5.85	2.75	8.97	7.90	4.57	2.08
Na_2O	1.49	3.28	2.39	3.36	4.32	3.14	2.70	3.39	3.18
K_2O	1.15	1.72	1.44	0.15	0.87	0.12	0.26	0.82	2.27
P_2O_3	0.15	0.33	0.24	0.17	0.14	0.07	0.21	w22	0.14
H_2O+	5.12	3.90	4.51	3.45	2.43	2.64		-	2.44
H_2O-	0.43	0.20	0.32	-	0.31	0.35	-	-	0.27
Lot	1.19	2.38	1.79	1.13	-	-	-	-	-
Total	99.81	99.86	99.84	99.98	100.19	99.88	99.04	100.00	99.57
SiO_2/Al_2O_3	3.13	3.05	3.09	3.64	3.09	3.91	3.26	3.77	5.25
SiO_2/TiO_2	49.98	38.92	42.52	38.24	77.61	101.08	27.67	69.98	135.14