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Modified silicified ecology at crater lake, Lonar, Maharashtra, India

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Abstract

Silicified rocks have been detected near Lake Periphery, Lonar, where SiO_2 content shows 99.5-99.8 % mass. Due to this, these rocks show milky white color and glassy type color of fully formed silica rocks. Representative rock samples of these types collected from the Lake Periphery and analyzed by XRF showed that SiO_2 was 99.5-99.8 mass %, which is nearly 100% silica or pure silica. This process known as silicification starts from white rusting of rocks/white coating of silica on basaltic rocks, having 95-97 mass % SiO_2, and finally is the formation of milky white rock having 99.5-99.8 mass % SiO_2., which means the transformation of entire basaltic rock converted into silicate rock by silicified process (white rusting or white coating of rocks). The whole process of silicification is observed to take place near the Lake periphery. The lake consists of diatoms, silt consisting SiO_2 detected at the bottom, lake water, in the soil at the lake periphery and transformation of basaltic rocks to silicate rock, all these indicate that a large quantity of SiO_2 may be present in the Crater Lake or in the soil near lake periphery and hence, it is of the opinion that a distinct ecology i.e., SiO_2 dominated ecology operates or exist here which has been termed as modified silicified ecology or modified silica ecology, although concentration of NaCl is high, yet it does not interfere with modified silica ecology or modified silicified ecology. What today exists at Lonar Crater is the silicified ecology. Being a preliminary investigation, this paper reports the findings and to put on records the observations and the findings.

Keywords: Lonar Crater Lake, basaltic rocks, silicification, milky white and glassy type rocks, modified silicified ecology.

Introduction

Lonar Crater being a totally different crater formed on rocks of volcanic origin (i.e., basalts), the co ordinates are $19^0 58'$N and $76^0 30'$E. The diameter of the crater is approximately 1.83km and the depth is approximately 150 meters depth. At the bottom of the crater, a lake exists consisting of saline and alkaline nature of water. The lake is surrounded by thick evergreen forest and on the periphery of the lake temples are found in a ruined state. The rim of the crater is found to be circular in shape and is well preserved. On the outer side of the crater white dusty powdered type of soil is found known as ejecta blanket. The formation of Deccan Plateau is found to be around 65 ma, whereas the formation of crater is very young compared to Deccan Plateau formation.

Some of the earlier works carried on Lonar Crater: Badve et al. carried out microscope examination of silt from Lonar Lake and found rich organic remains like algal filaments, fungal hyphae and spores, diatoms, etc. They also isolated thermophilic and alkalophilic streptomycetes and stated that their occurrence is significant because findings of these microorganisms suggest for hot springs nearby, the water of which may have gone to the lake, but in due course these hot springs must have been buried because Lonar Crater lies in a structurally disturbed zone[1]. Nandy and Deo carried out analyses of lake water and silt from the five sets of samples shown in Table-1 and observed that the brine has the same composition laterally and also in height below[2]. Sarkar et al carried out detail work on secondary quartz and concluded that detail research work on crystallographic orientation of planar deformational features needs to be done[3]. From the studies on physicochemical analyses of lake water carried out by Shinde and More observed high chlorides, hardness and salinity from this, they concluded that alkalinity of the Crater Lake is found to be in higher range[4]. Borul carried out physicochemical analyses of lake water and found that lake water shows light green to dark green color which is due to large algal population and found that Spirulina is predominant[5]. Pawar carried out seasonal variation by taking lake water samples and through physicochemical analyses concluded that chloride and salinity was found to increase in pre-monsoon and found to decrease in monsoon and post monsoon[6]. Gaikwad and Sasane carried out detail work on Lonar Lake water along with groundwater of the surrounding areas and through physicochemical analyses concluded that water supplied to rural areas should be treated and also needs protection from contamination[7]. Hagerty and Newsom studied samples from drill cores made at crater floor, Lonar and concluded that clays formed due to hydrothermal alteration at Lonar, the data of which when compared with respect to other small impact craters of terrestrial origin showing lower size limit, points out that hydrothermal system can also be formed and be sustained which can give rise to silt alternation which is somewhat lesser than Lonar Crater diameter[8]. Komatsu et al studied various drainage systems of Lonar Crater and their investigations revealed that, the level of water of the lake is found to increase by surface runoff which is found to be active in the rainy season and also water from ground which comes to the lake is found to be effective in both the seasons i.e., rainy and dry[9]. Murali et al studied tektite like bodies from Lonar Crater and concluded that tektite like bodies and basalts at Lonar are related through addition of silica content which results in leaching out other major and trace elements[10]. Nayak studied glassy like objects, which resembles glasses in search of shock features in breccias, crushed materials, formation of unusual rocks which showed that plagiosclase feldspars were found to be broken and twisted, fractures of irregular type, fractures of planar etc were observed. Nayak also found that some basalt was found to be highly oxidized from these he concluded that all these features are related to an event of impact origin[11]. Chakrabarti and Basu analyzed trace elements and Nd, Sr, Pb-isotopes of impact breccias rocks and target basalts which were collected from Lonar Crater, the conclusion drawn shows that assimilation of inter-trappean sediments consisting of chert, limestones and mesazoic animal fossils, into impact breccias cannot be assigned to Archean Pb-isotopic components which are seen in impact breccias[12]. Stroube et al determined 29 elements through analyses by INAA of impact glass samples and basalt samples of Lonar Crater, through these studies, they concluded that the REE found in basalt samples and glass samples shows similarity, the impact glass samples and basalt samples show patterns having similarity, the samples of which were taken through core 2 and at a height 345m below the ground[13].

Scope of work: Lonar Crater is modified or silicified ecology. Polymorphs of silica means different types of silicates e.g., quartz, christobalite, tridymite (these polymorphs of silica is found in volcanic craters or volcanic rocks), and high pressure polymorphs i.e., stishovite and coesite (these polymorphs of silica is found where impact by meteorite has occurred). They are different from each other in their structure. These may be a source of economy. The polymorphs of silica found in the form of silica pebbles/white pebbles, milky white and glassy type of rocks, being amorphous in nature may belong to one of these forms[17], or other forms.

Background: There are two ecologies adjacent to each other operating and functioning independently at Lonar Crater. Both ecosystems have absolutely different components. Lonar Crater ecology is small and unique ecology. The sandy soil of this ecology is similar to the sea perhaps; it contains a major amount of silica, iron and major amount of Aluminium gradually decreasing in order and other oxides are in trace amounts. These prominent oxides reflect or impart its color to the soil. So it is whitish gray in color. The rock ecology is of this system is very strange and has very complex mechanism, which converts basaltic rocks into silicified rocks. After disintegration of this silicified rock ecology get enriched in silica pebbles, silica sand etc., due to the above three mechanisms operating, the ecology in that particular Lonar Crater is found to be of silicified ecology. The ecosystem mechanism is driven by white rusting of rocks which convert basaltic rocks into silicified rocks in presence of diatoms in the lake water and also abundance of pebbles distributed over there. So the components of ecosystem are white rusting, silica pebbles diatoms, milky white colored rocks and glassy type of rocks. They are interacting with each other to sustain the silica ecology. Hence there are no organisms in such ecosystem who survive or develop other than that found in the lake, who have adapted silicified ecology or there may be existence of another unknown organisms (zoo planktons or phyto planktons) who may be supporting silicate cycle because they are originated from silicates existing at the lake. So this lake water contains diatoms or may be microorganisms i.e., phytoplanktons or zooplanktons survive who have developed this silicified ecology. But as per this study findings, soil contains 23.201% mass SiO_2, The water contains 1.46% SiO_2^2. The silt contains 42.40% SiO_2^2. And milky white rocks and glassy types of rocks contain 99.5-99.8 mass % SiO_2 (this study). So silica regenerate and reform in that restricted area interacting only with above components. This is the beauty of the lake.

Table-1: Physical Properties of milky white and glassy types of rocks from Lonar Crater

Sample No.	Weight in gms	Density g/cc	Color	dimensions in cms	Shapes
LRS-12	4.1395	2.06975	milky white		Irregular
LRS-02	12.6235	2.5247	glassy type	3.4x2.5x1.4	Irregular
LRS-07	12.4517	2.49034	glassy type	3.9x2.6x1.5	Irregular
LRS-14	8.5416	2.8472	glassy type	3.1x1.6x1.4	Irregular
LLRS-27	11.44816	2.86204	milkywhite cum glassy type	3.2x2.1x1.5	Irregular
LLRS-29	8.28496	2.07124	milky white cum rocky	3.1x2.1x1.3	Irregular
LLRS-30	19.58896	2.44862	milky white cum rocky	4.0x3.4x1.5	Irregular

Figure-1: Rocks covered by white rusting found at Crater Lake, Lonar.

Figure-2: Rocks covered by white rusting found at Lonar Crater Lake.

Figure-3: Rocks covered by white rusting found at Crater Lake, Lonar.

Figure-4: Grayish white type of soil found at Crater Lake, Lonar.

Figure-5: Rocks covered by white rusting found at Crater Lake, Lonar.

Figure-6: White coated rock in the lake water, Lonar.

Figure-7: Milky white color on silica rock found at Lonar Crater Lake.

Figure-8: Milky white and glassy part of silica rock found at Lonar Crater Lake.

Figure-9: Full formed silica rock (white) from basaltic Rock found at Lonar Crater Lake.

Figure-10: Full formed silica rock (glassy type) from basaltic rock found at Lonar Crater Lake.

Methodology

The milky white type of rocks and glassy type of rocks showing similar features were collected as a representative samples from Crater Lake and kept in a polythene bag for further analysis. Of the two milky white rocks one was crushed for XRF analysis to study its elemental composition and oxide composition, the others were also studied by XRF through whole rock analysis and spot analysis for oxide and elemental composition.

Physical Characteristics: The color of the rock samples under study are milky white and glassy type. Their weights, their density and dimensions are given in Table-1. They are of irregular shapes and sizes.

Experimental results: From the results by XRF analysis, Appendix-1 and 2 of the powdered samples, analysis of whole rock samples and spot analysis of milky white rocks and glassy type of rocks shows that SiO_2 is found to be 99.5-99.8% mass with other oxides in trace quantities. Since the samples under study are transformation process of basaltic rocks to silica rocks, it may be of amorphous nature.

Results and discussion

The results obtained by XRF analysis (X-ray fluorescence) of the twelve parts of different samples under study shows that the major or dominant component is silica (SiO_2) which is 99.5-99.8% mass with other oxides such as Al_2O_3, Fe_2O_3, CaO, ZnO, CuO, PbO etc. in trace amount. Detail analysis is given in Appendix-1 and 2.

Chemtob mentioned various factors responsible for silica coating on basaltic rocks[14]. Lonar is affected by two events: i. volcanic eruption of 65ma and ii. formation of a crater 656ka[15]. Chemtob reported white rusting of rocks on Kilaea flow in Ka'u Desert on Hawaiian volcanic islands[14], where volcanic eruptions are a frequent process. At Lonar volcanic activity has ceased long back. No volcanic activity has taken place. Hence silicification of basaltic rocks at Lonar cannot be attributed to volcanism because for white rusting to take place basaltic rocks must have 95% mass SiO_2. This is inferred from the observations of different rocks under study and their XRF analysis showing these features. The analysis of basaltic rocks today by different researchers and this study shows that the value of SiO_2 is around 50-52% mass. Hence at Lonar if one sees a different mechanism may be operating.

From the observations of basaltic rocks near Lake Periphery in 1997 in the northern part of the lake, rocks showing white rusting or white coating was observed to some distance. At first, it was thought that these rocks were painted with white color for defining the boundary of the lake, that, it is a manmade activity After this, several visits to the Crater Lake these rocks were found to be submerged in the lake water. From this it was inferred that it is a natural process and it shows that the lake water is a factor to operate the process of transformation of basaltic rocks to silica rocks. It is also observed that the temple stones near the lake periphery are covered by white rusting[16] which shows that water is responsible for the process of complete silicification of basaltic rocks. This process seems to be operating only in the lake and its periphery and not beyond that.

Badve and Kumaran mentioned that the lake water contains diatoms[1]. Diatoms are found in marine environment and fresh water. These diatoms are related to algae groups. Organisms such as diatoms are indicators of SiO_2. Skeleton of diatoms is made mostly of silica. It is postulated or assumed that debris of these diatoms is recycling of SiO_2. Micro organisms which exist in the lake take the energy from these dead diatoms in this process SiO_2 is released in the water. SiO_2 has been detected in the silt at the bottom of the lake[2]. Since SiO_2 is insoluble in water it remains in the water, but cannot remain for a very long time. While in rainy season, the water level rises, the rocks near the lake periphery gets submerged; this is applicable to temple rocks or temple stones also.

The level of the lake water decreases in winter and summer, SiO_2 in the water deposits on the rock. This process goes on and on and year after year. For this, climatic conditions must also be assisting. As the level of water increases or decreases each time, the deposition of SiO_2 on the rock takes place. In this way as the deposition increases each time, the encapsulation of SiO_2

on basaltic rock goes on increasing. Each time the rock is submerged in the water some amount of SiO_2 deposits on the rock. As basaltic rocks disintegrate due to weathering conditions, apart from SiO_2, there are other oxides in the basaltic rocks which leachate out, also due to halogen group elements like Chlorides, Bromides and fluorides, these elements are highly corrosive and may be reacting with basaltic rocks. SiO_2 does not disintegrate; it remains as a complete mass. Since the rock is of basaltic origin, it becomes easier to encapsulate the rock or deposit on these rocks. Hence the percentage of SiO_2 is found to increase on the rock. While the rock attains 95-97% mass SiO_2, white rusting/ white coating of silica is observed. Slowly as the deposition goes on increasing, SiO_2 tries to dominate the entire rock or takes over the entire rock by encapsulation.

Finally when the whole rock is encapsulated to 99-100% mass SiO_2, the color of the whole rock is found to be milky white or glassy type, who can be said that silicified process is complete. This is pure silica. It is observed that only stones are affected. Entire stone in that particular area are mostly basaltic rocks. These rocks undergo silicification i.e., natural phenomena which converts entire basaltic rock into pure form of silica. The silica becomes concentrated or this environment becomes richer and richer in silicates for many years. So predominant element is silica, hence ecology becomes modified into silica ecology. The silica ecology reflects or represents silica or silicate through diatoms, which undergoes silicate cycle.

From this study one thing is clear that the condition for formation of white rusting, silica pebbles or other forms such as milky white rocks and glassy type of rocks, additional source of SiO_2 must be available for encapsulation. Unless and until large quantity of SiO_2 is available, white rusting/white coating, silica pebbles or silicified process or mechanism is not possible. In the entire silicified process, i.e., from white rusting to milky white rocks and glassy type of rocks, all this process operates in the water and its periphery, and hence it can be said that water may be the major factor for silicified mechanism to operate.

Dominance of silica is seen in the form of white rusting, silica pebbles, milky white and glassy type i.e., dominated silicified ecology is observed through these phenomena which have not been observed in any part of the earth except at Lonar Crater. This silicified dominated ecology, how it operates, what is the mechanism for its operation is totally unknown, the source of large quantity of SiO_2 found at the Crater Lake and its periphery is also unknown, or it can be said that the lake is filled with silica or silica ecology operates here.

Diatoms control the ecological cycle, hence the amount of silica is constant, diatoms are not the source of SiO_2, Their skeletal body is made up of SiO_2, they are biological indicators, that their existence shows that there is a large quantity of SiO_2. Hence it can be inferred that there may be SiO_2 below the crater, because as per Nandy, the percentage of SiO_2 at the bottommost silt bed is higher than the topmost silt bed[2], which may supplement SiO_2 for white coating of rocks, which are on the periphery of the lake.

It is also stated that the assumptions or postulations given above may not be a complete theory or complete proof. There may be other source unknown, but exist in the lake, for which otherwise it is not possible for silicified process to take place. This is the best explanation offered to the high percentage of SiO_2 observed on basaltic rocks which changed their original form of basaltic origin (black color), to milky white color glassy type color of silica origin.

It can be said that silicification is one of the oldest process operating continuously in the environment of Lonar Crater from the time the lake was formed. Hence the effects of silicification are observed or are reflected in the form of white rusting/white coating of silica; silica pebbles/Lonar pebbles/white pebbles, milky white rocks and glassy type of rocks.

This crater is the only crater where modified silicified process operates strongly or this crater lake is nothing but silica ecological cycle operated, which controls all the activities of the crater or silica ecology which controls all the reactions and hence formation of white rusting, silica pebbles, milky white rocks, glassy type of rocks and diatoms, which are all related to silica, SiO_2 in the silt, lake water and soil etc., large amount of silica may be in the lake and because of this, all the activities is influenced by silica ecology.

At Lonar two ecologies exist one is the Lonar ecology (saline and alkaline nature of lake water) including silicified ecology, and the other is the sweet water ecology. Biotic and Abiotic components of such ecologies are totally different from each other. There is no interaction among them. Although the two ecologies are adjacent to each other, each of them operates separately and individually. Lonar ecology does not take anything from the fresh water ecology and fresh water ecology does not take anything from Lonar ecology. The exchange of eco system does not take place. This is the uniqueness of Lonar Crater.

From the study of the representative rock samples, it infers that the rocks undergoes encapsulation by silica This inference is drawn from the observation of different rocks under study and the analysis of these rocks show that the formation of silica rocks from basaltic rocks are a part of one single process. Hence it can be said that the mechanism operating at Lonar crater is totally different from that of white rusting process observed on other volcanic eruption site, although Chemtob mentioned other factors are also responsible for the formation of white rusting[14], here at Lonar Crater, water is the major factor responsible for the formation of not only white rusting, but is also responsible for the whole process of silicification.

And this process is controlled by silica ecology which exists at the Crater Lake and is known as silicified ecology.

Except white rusting/white coating of silica, silicified process of the whole rock has not been reported from any of the volcanic eruption site around the globe, although volcanic eruption is the dominant factor for formation of white rusting/white coating phenomena[16]. From this it infers that for silicified process, the value of SiO_2 must be above 95% mass. This inference has been drawn from the analysis by XRF of those rocks which has undergone white rusting, silica pebbles, milky white rocks and glassy type of rocks and at present is showing the same features. In short silicification means coating of basaltic rocks by silica, which is undergoing complete transformation into 100% silica. Then only can one say that the silicified process is complete for that rock.

The period required for complete transformation of silica in silicified process is unknown. As per this study some rocks under silicified process and some other rocks transformed or disintegrated into 100% silica. The result of this is the findings of silica pebbles[17], rocks showing milky white and glassy type rocks in this influenced area.

White rusting phenomena or process as mentioned in our earlier paper[16], is a universal phenomenon because it has been observed on Mars and Moon[14]. It is also possible on other planetary bodies etc. And this phenomena is found outside the earth's environment i.e., on the moon, Mars etc. At Lonar, the formation of white rusting, silica pebbles, milky white rocks and glassy type rocks has been discussed in detail. On other planetary bodies, where these white rusting or white coating of silica is observed, other factors as mentioned by Chemtob may be responsible, it may not be similar to Lonar, but the features or phenomena is a universal process, although different mechanism may be operating according to different factors as mentioned by Chemtob or factors totally different may be responsible which may not exist on earth, but exist on other planetary bodies, but the process of formation white rusting, and finally the milky white or glassy type rocks. All these are of one and single event altogether and is termed modified silicified ecology or silicified ecology.

Conclusion

From the observation of physical features, analysis by XRF, and through, discussions, it is inferred that the different types of rocks of basaltic origin encapsulated by silica, when analyzed showed SiO_2 to be from 95-99.9% mass, different forms of silica is seen depending on the content of SiO_2 i.e., white rusting, silica pebbles, milky white rocks and glassy type rocks are all related to one and single event i.e., silicification.

The milky white rocks and full glassy type rocks included in this study is finally silicification of the whole basaltic rock to silica rock having nearly 100% silica. All these formations is observed, and it can be inferred that a huge or large quantity of SiO_2 may exist in the lake, but unknown, where the process of silicified ecology exist, presence of diatoms, SiO_2 in silt, water and soil indicates that a source must be available to operate the whole process and that is silicified ecology which has been known to operate from our studies carried out on different rocks and discussions, and since this lake is an inland water body, this silica ecology is strictly restricted to this particular area only, which means that a silicified ecological cycle may be operating, because the content of SiO_2 remains constant, although basaltic rocks contain SiO_2 in the range between 50-52% mass (through XRF analyses), but the extra ordinary SiO_2 to encapsulate the rocks existing on the lake periphery needs to come through some source and the source may be through water, or the source may lie below the water which is totally unknown Diatoms found in the lake water are not the source, because the source was available and hence diatoms came into existence here.

The silicified process of basaltic rocks to silica rocks stands witness to the process or mechanism which operates at the Crater Lake. Hence it can be concluded from the above, that the silicified process observed at Lonar Crater Lake is not related to volcanic eruption, but is related to the lake water and the environment existing at the lake. This crater is the only crater in the world, where silicified process takes place, where the lake contains large quantities of SiO_2 which has not been observed anywhere in the history of crater formation. The different forms of silica depending upon the percentage of SiO_2, observed at Lonar Crater Lake, the whole silicified process is very important because the mechanism of its operation is unknown, it will be a new subject of research altogether.

These types of rock formation (transformation of one form to another) have not been observed on any part of the earth, nor has it been reported except at Lonar, these formations are observed. Findings of these types of rocks formations will open a new window of research altogether to their formations, mechanism and how this process operates in nature. If this mechanism of preservation by silicified process is known, it will be a new subject altogether for preservation of non-living and living. Finally it can be concluded that Lonar Crater ecology is silicified ecology, though the concentration of NaCl is high, yet it does not interfere with silicified process.

Importance of work: If the mechanism of white rusting/white coating is discovered and why nature is trying to sustain this ecosystem in that particular area, what is the purpose, or what is the reason for nature to emphasize on this silica ecology or modified silicified ecology, the beauty of the work is that if man is able to convert basaltic rocks into silica rocks, by knowing the above mechanism, it will be the greatest achievement in the history of man.

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Appendix-1: Analysis of milky white phase and glassy types of rocks from Lonar Crater by XRF.

Oxides↓	1	2	3	4	5	6	7	8	9	10	11	12
SiO_2	98.5	98.8	98.2	99.5	99.6	99.3	99.3	99.3	99.8	99.3	99.3	99.4
Al_2O_3	0.825	0.996	0.521	0.345	0.339	0.531	0.542				0.365	0.431
Fe_2O_3	0.163	0.0495	0.239	0.122	0.0186	0.0278	0.0291	0.0307	0.0185	0.0392	0.0573	0.0308
CaO	0.208	0.137	1.01	0.0466	0.0657	0.121	0.123	0.425	0.127	0.348	0.184	0.173
SO_3	0.26							0.13		0.0856		
Cr_2O_3			0.0083									
ZnO	0.007	0.0064	0.008	0.008	0.0127	0.0125	0.00129	0.0043	0.0042	0.004	0.0093	0.0049
CuO	0.0032	0.0029	0.0042	0.0034	0.0092	0.0091	0.0093	0.0036	0.0162	0.0034	0.0027	0.0029
PbO	0.0004	0.0003		0.0003	0.0005	0.0005	0.0003	0.0002				<0.0001
MnO								0.001			<0.0001	<0.0001
TiO_2			0.0265							0.0048	0.0053	<0.0001
NiO			0.0019					0.0013	0.0008		0.0008	0.0011
K_2O										0.231	0.0856	
SrO								0.0005	0.0003	0.0012		0.0004
Cl								0.0553	0.0349	0.0172		
ZrO_2								0.0014	0.0011			0.0014
SnO_2								0.0002			0.001	
MoO_3												0.0009
Nd_2O_3												0.0008
CdO							0.0002					
BaO										0.004		
Total	99.9666	99.9921	100.019	100.03	100.046	100.0019	100.0052	99.9535	100.003	100.038	100.011	100.0472
Legend												

1. Spot analysis of glassy of rocks sample No. 1
2. Spot analysis of glassy part of rock sample No. 2
3. Full milky white rock sample no. WR-1-17
4. Full milky white rock sample No. LRS -12
5. Full glassy type rock sample No. LRS-02
6. Full glassy type rock sample No. LRS-07
7. Full glassy type rocks sample No. LRS-14
8. Milky white cum glassy type sample No. LLRS-27
9. Milky white part on basaltic rock
10. Milky white cum glassy type on basaltic rock
11. Milky white part on rock cum milky white sample No. LLRS-29
12. Milky white part on rock cum milky cum glassy type sample No. LLRS-30

Appendix-2: Analysis of milky white phase and glassy type of rocks from Lonar Crater by XRF.

Elements ↓	1	2	3	4	5	6	7	8	9	10	11
Si	97.9	98.6	95.6	99.1	99.4	99.1	99.1	98.5	99.4	98.2	98.9
Al	0.694	0.846	0.43	0.281	0.302	0.479	0.501				0.326
Fe	0.428	0.131	0.778	0.391	0.0433	0.062	0.0608	0.0733	0.047	0.089	0.13
Ca	0.537	0.356	3.02	0.175	0.152	0.265	0.257	0.997	0.317	0.843	0.415
S	0.369							0.168		0.112	
Cr			0.0266								
Zn	0.0217	0.0196	0.0312	0.03	0.0345	0.0323	0.0311	0.012	0.0124	0.0111	0.0244
Cu	0.01	0.0089	0.0159	0.0128	0.0246	0.0231	0.0221	0.0097	0.047	0.0093	0.0071
Pb	0.0017	0.0012		0.0014	0.0015	0.0013	0.001	0.0005			
Mn								0.0028			<0.0001
Ti			0.072							0.0122	0.0104
Ni			0.0071					0.0034	0.0023		0.0021
K										0.628	0.223
Sr								0.0014	0.0011	0.0035	
Cl								0.18	0.12	0.0566	
Zr								0.0036	0.0031		
Sn								0.0006			
Mo											0.002
Nd											
Cd							0.0006				
Ba										0.011	
Total	99.9614	99.9627	99.9808	99.991	99.9579	99.9627	99.9736	99.9523	99.9499	99.9757	100.04

Legend
1. Spot analysis of glassy part of rocks sample No. 1
2. Spot analysis of glassy part of rock sample No. 2
3. Full milky white rock sample no. WR-1-17
4. Full milky white rock sample No. LRS -12
5. Full glassy type rock sample No. LRS-02
6. Full glassy type rock sample No. LRS-07
7. Full glassy type rocks sample No. LRS-14
8. Milky white cum glassy type sample No. LLRS-27
9. Milky white part on basaltic rock
10. Milky white cum glassy type on basaltic rock
11. Milky white part on rock cum milky white sample No. LLRS-29

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