

# **Pumice Formations in the Area Uzon Depression- Geysernaia River Valley in Kamchatka \***

---

V. I. BELOUSSOV, B. V. IVANOV

Institute of Volcanology, Siberian Division, USSR Academy of Sciences

---

The area Uzon depression - Geysernaia river valley lies in the Eastern Kamchatka volcanic zone and is located in its central part. It is characterized by a wide development of Recent hydrothermal activity and of a Recent and Late Quaternary volcanism. The formation of a great amount of pumices is associated with the last outbursts of volcanism.

## **Geology of the Area**

The oldest rocks in the area Uzon depression - Geysernaia river valley consist of a thick mass of volcanic-sedimentary strata represented by a series of alternating beds of tuff breccia, conglomerates, psephytic, aleuropelitic and pelitic tuffs. The most complete sequences are in the valley of the river Geysernaia. By separate exposures this rock mass can be traced west of the Geysernaia river up to the rim of Uzon caldera, where it descends under the ring structure of Uzon without changing its lithological composition (this is true for the top horizons represented by aleuropelitic tuffs).

The volcanic-sedimentary rock mass is directly overlain by pumices. They are characterized by an uneven distribution over the area. Thus, for instance, in the exposures of the river Geysernaia pumice deposits form a rock mass 150-200 m thick. To the south-east the rock mass peters out very rapidly. The attempt to trace pumice deposits in the eastern direction was unsuccessful, because this part is covered by extrusive lava flows. In the western direction — towards

---

\* Paper presented at the IAV International Symposium on Volcanology (New Zealand), Nov. 1965.

the Uzon depression — the pumice rock mass is not found everywhere accompanying, mostly, with extrusions. In the depression itself no pumice deposits have been recorded.

In the north, near the Kikhpinich volcano, the thickness of the pumice rock mass diminishes. In the north-east the facies of pumice deposits are replaced by rudite breccias.

The second rock complex is represented by effusive-extrusive forms. The latter are especially widely developed in the eastern part of the area, — within the valley of the river Gysernaia. In the eastern part of the area the masses of extrusive bodies are of an exceptionally big size. Their formation took place by a coalescence of several extrusions located near each other.

The majority of extrusions in the eastern part of the area have small lava flows. The chemical composition of these extrusions corresponds to andesite-basalts ( $\text{SiO}_2$  - 56 %), andesites ( $\text{SiO}_2$  - from 58 to 61 %) and andesite-dacites ( $\text{SiO}_2$  - 64 %).

This probably explains the low viscosity of the extrusion material. Moreover, as indicated by chemical analyses, the composition of effusive-extrusive rocks includes a great amount of water (up to 2 to 4 % of the total rock mass), which should also lead to a drop in dynamic viscosity.

The greater part of the effusive-extrusive rocks is represented by glassy varieties of andesites and andesite-dacites. Phenocrysts are represented by plagioclases, augite and hornblende, the groundmass consisting of volcanic glass with crystallites.

In the western direction the nature of the extrusions changes. Their apical parts are located at lower hypsometric levels and form plateau-like surfaces. In the direction towards the Uzon depression the height of extrusive domes diminishes to several tens of meters. Small domes are placed near each other. The volume of ejected material in these extrusions is not big. No lava flows have been observed. In the northern and south-eastern parts of the area Uzon depression - Gysernaia river valley the morphology and composition of extrusions is to a great extent similar to the morphology and composition of the extrusions in the eastern part.

The geological structure of the area is mainly characterized by an undisturbed occurrence of the volcanic-sedimentary rock mass. Thus, for instance, the roof of the aleuropelitic tuff horizon on the eastern slope of the Gysernaia river valley up to the western slope of the Uzon depression lies on one level all the time. However, the

term « undisturbed » should be understood only in a relative way. As the formation of the volcanic-sedimentary rock mass took place in a marine basin, it should be assumed, on the basis of the present hypsometric position of the volcanic-sedimentary rock mass, that during the Quaternary period this area was subjected to an intense regional uplift with an amplitude of 800-1000 metres.

Besides an extensive regional uplift, the injection of extrusions caused local disturbances in the correspondence of the horizons of the volcanic-sedimentary rock mass like breaks in the continuity of beds, their tilting and bending, the creation of a block structure in the rock mass. Some blocks were uplifted by the extrusions. In a number of cases the amplitude of displacement comes to 300-400 m.

At the present time shoves continue to take place in some sections of the area, which is sometimes reflected in the structure of river valleys. For instance, in the upstreams of the river Shumnaia, there is a greater number of terraces in the portion where minor extrusive domes are developed.

### **Palaeogeography of the Area during the Late Quaternary Period**

Glacial deposits of the last phase of the Upper Quaternary glaciation are widely developed in the Uzon depression. By geomorphological features the fact of the existence of a glacial cover in the valley of the depression can be distinctly established (trough valleys, moraines). The same is true for the valley of the river Geysernaia. A study of the morphological structure of the extrusions and of the extrusive massifs, as well as an investigation of the lithological composition of the morainic material enabled us to establish that the injection of the extrusions took place under the conditions of a glaciation.

At the present time similar conditions are characteristic for certain regions of Iceland. T. BARTH (1950) indicates that a most characteristic event of subglacial eruptions is an « ice explosion » (Jökulhlaup in Icelandic), as result of which intermittent streams are formed with a yield of about 200,000 m<sup>3</sup>/sec<sup>(1)</sup>. Similar eruptions could have taken place also in the area Uzon depression - Geysers-

---

(<sup>1</sup>) For a comparison — the discharge of the world's largest river, the Amazon, is 20,000 m<sup>3</sup>/sec. (BARTH, 1950).

naia river valley. Approximate computations show that an extrusion of average size in the area Uzon depression - Geysernaia river valley could emit so much heat that as a result of the effect of the extrusion on the glacier an intermittent stream could have originated with a water discharge of about 10,000 m<sup>3</sup>/sec, which would function for 5-7 days. Such water streams possess a great reserve of kinetic energy. They could do a big work on washing and transferring material. It seems to us that the erosional entrenchment of the valley of the river Geysernaia, and, to a great extent, that of the valley of the river Shumnaia took place as a result of the activity of such water streams.

### **Pumices**

Pumice deposits in the area Uzon depression - Geysernaia river valley are of two types: a) loose and slightly consolidated clastic pumices, and b) «*in situ*» pumices of extrusions.

*Loose and slightly consolidated clastic pumices.* As already mentioned, the mass of loose and slightly consolidated clastic pumices is unevenly distributed. Maximum thicknesses of the rock mass are observed in the north-eastern part of the area.

The rock mass is characterized by an absence of sufficient sorting and a purely pumice composition of the fragments. The size of the fragments varies within a wide range: from fine pumice crumbs to big boulder-like lumps. The pumice is highly porous, light and looks like a foamy finely porous glass. The pores are of a small size and elongated shape. The porosity comes to 80-85 % and sometimes even 90 % of the rock volume. The colour of the pumice varies from light grey to yellowish-white in different parts of the area. Under the microscope the pumice is like a cellular tissue of wood (elongated pores separated by extremely thin partitions of glass). Phenocrysts are very rare.

«*In situ*» pumices of extrusions. The distinction of this type is determined by their distinct genetic relations to the extrusions and by a different character of occurrence. These pumices are found in apical parts or on the flanks of minor extrusions developed near the head of the Shumnaia river valley.

The majority of minor extrusions in this part of the area are

characterized by textural changes of the material in apical parts or on the slopes of the extrusion; the socle consists, usually, of compact andesites or andesite-dacites, which gradually change upwards along the sequence into porous varieties and later into pumices. By its appearance « *in situ* » pumice does not differ from fragmental pumices occurring near-by.

### The Genesis of Pumice Forms

The formation of « *in situ* » pumices took place during the injection of the extrusions. As indicated by chemical analyses, the rocks that form the extrusions contain from 2 to 4 weight percent of water. Such rocks belong to perlites. When heated perlites get degassed, heaved, they increase in volume and form porous rocks (PETROV, 1963).

The heaving is caused by a change of a part of water into a gaseous state under high temperatures and a low pressure. If the porosity of the pumices is 80 % and the temperature of the injected masses comes to 800°C, only 0.2 weight percent of water will be needed for a heaving. Inasmuch as the actual water content in the rocks comes to 2-4 %, the concept of « heaving » is sufficiently justified in explaining the formation of « *in situ* » pumices.

Apparently, the formation of intermittent water streams with big discharges was taking place during the injection of extrusions. As a result of their activity there has been an intense destruction, transport and redeposition of pumices with the formation of clastic pumice rock masses.

### Bibliography

- Петров В. П. Пемза и шлак, их практическое значение и генезис. — Сб. Вулканизм Камчатки и некоторых других районов СССР. М., 1963. (Pumices and slag, their practical importance and genesis).
- BARTH, T. F. W., 1950 - *Volcanic geology, hot springs and geysers of Iceland.*