GENESIS OF BASALTIC MAGMA FROM THE QUATERNARY VOLCANOES OF SPITSBERGEN (SVALBARD) ARCHIPELAGO

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The archipelago of Spitsbergen is located in a far northwest part of the Barents Sea shelf and represents the most northwest part of Eurasia. The Spitsbergen is one of the key places in the Arctic basin, as the basic stages of a geologic history are fixed here during geodynamic progressing of the region.

Volcanic structures of a Cenozoic are confined to a regional plutonic Breibogen fault which was foundated for a final stage of the Baikal folding or on the initial stages of the Caledonian tectogenez. This disturbance is most important in tectonic meaning; since it is long-living, plutonic fault (vertical amplitude of displacement is about 1500 m in area Bock-fjorden). Breibogen fault was numerous activated in Post Devonian time. For example the revival of tectonic movements has resulted in forming basalt overlying strata's in Neogene, and to formation of a Sverrefjellet volcano, Halvdanpiggen and Sigurdfjellet diatremes in Quaternary time.

The Quaternary volcanoes are laid out in a narrow and extent zone - Breibogen - Bock-fjorden. They are introduced of three volcanic constructions - most northern stratovolcano Sverrefjellet, then diatremes Halvdanpiggen and Sigurdfjellet. The age of Sigurdfjellet - 2,7 Ma, Halvdanpiggen - 2 Ma, and Sverrefjellet 10 and 6 thousand years. The Quaternary basalts composition is referred to derivatives of alkaline - olivine - basaltic magma. Quaternary volcanism protruded from the south to north, this direction coincides with tectonic opening of the Norwegian-Greenland basin. [1].

The results of the petrochemical investigations of Spitsbergen basalts , which constructed upper zones of volcanoes Sverrefjellet and Halvdanpiggen , confined to plutonic faulting zone Breibogen - Bock-fjorden has shown, that the basalts are referred to alkaline rocks(basanite –lamburgite), the contents of potassium in which one reaches 1,5-2 %.[2].

Magmatism of Knipovich ridge, which evolution in its modern position was simultaneously with the activity of the volcanoes Sverrefjellet and Halvdanpiggen, differs by the tholeiites tendency, relatively concentration of sodium and low-deep genesis. At the same time, tholeiites have slight enriched character of lithophile and radiogenic isotopes [3].

Both by compositions of magmas, and by rock-forming minerals content, the volcanoes are close that mirrors similarity of magma generation conditions during from 2 Ma (Halvdanpiggen) up to 6 thousand years (Sverrefjellet) ago.

A plenty of mantle inclusions is a distinctive feature of magmas of these volcanoes. Disseminations of olivines and pyroxenes from basalt on 70% are corresponding to composition of mantle minerals. They differ by the low content of CaO in magnesian (Fo 91,5-90,5) olivines and high atomic Mg #(91,5-92,5) in clinopyroxenes. In figure 1 the distinction in concentrations CaO in olivines of mantle and basalt floods is shown. It is necessary to note, that the mantle olivines were difficult, if it is not possible, to distinguish from magmatic ones. It is necessary to allow, when the speech goes about total composition of rock, as the plenty magnesian xenocrysts will influence on bulk composition of basalt.

The contents of rare elements in clinopyroxenes of basalts are characterized by gentle concentration of the most incompatible elements from Ba up to Sm with characteristic for clinopyroxene by minima on Zr. It differs from the majority of basalt magmas (trapp, tholeits, up to modestly alkaline), for which the clinopyroxene is the third crystallizing phase, following for olivine and plagioclase. For this magma the crystallization of clinopyroxene probably was after olivine generation.

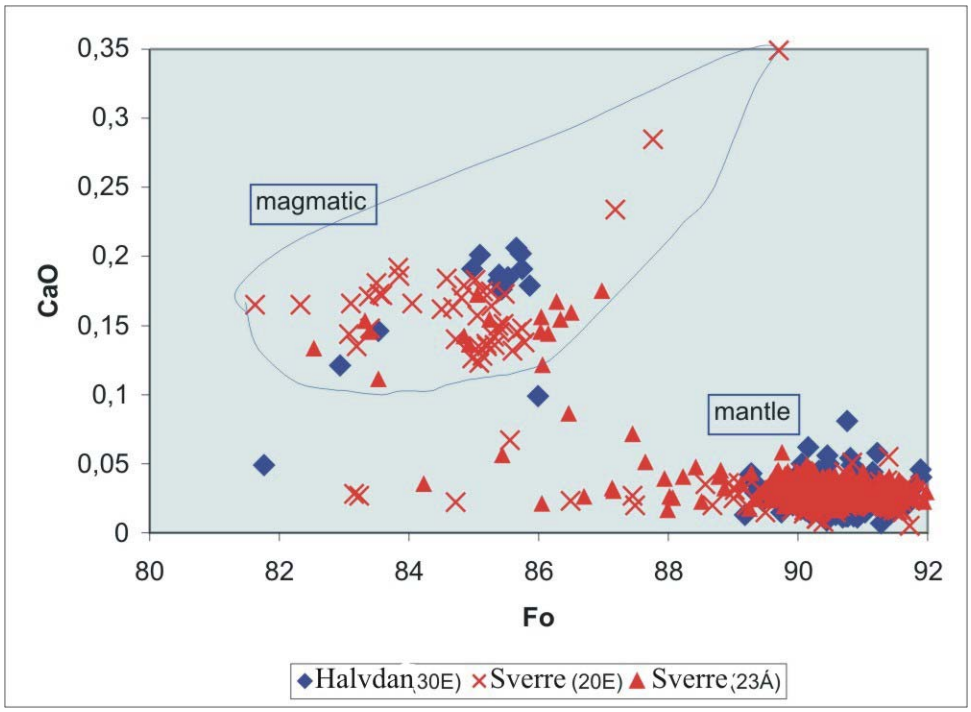

Fig. 1. Composition of olivine in Quaternary magmas of Spitsbergen

The estimation of its crystallization pressure was held with the use of Nimis method on composition of magmatic clinopyroxene. The method, is based on the held study of clinopyroxene composition [4], for which it was established a linear correlation between volume of a cell (V_{cell}) and a size of a position M_1 (V_{M1}) at the predetermined pressure. The volumes of V_{cell} and V_{M1} are linearly decrease while the pressure is increase at the determined stable composition of melt. On the basis of these dependences the pressure can be introduced as linear function from V_{cell} and V_{M1}. There is a temperature dependence of location of iron and magnesium on positions M_1 and M_2, which one is allowed at account of mathematical constants participating in the equation [4]. The estimated inaccuracy for anhydrous and saturated magmas compounds no more than 1,70 kbar. It is necessary to note, that the used geobarometer was calibrated on rather magnesian samples [4]. The analytical error of the method grows while magnification of a grade differentiation of object.

We counted evaluation pressures for temperatures 1150 °C on 70 grains of clinopyroxene. The result average level of pressure, at which fractionation of the original magmas were proceeded, is 8-9 kbar, it was testified to presence of the intermediate volcanic centers in plutonic conditions of a continental lithosphere.

The estimated depths of magmas crystallization are well correlated to the earlier received section of Spitsbergen lithosphere, demonstrating a location of the volcanic centers lower Moho boundary in transitional zone. It was reconstructed with the help of mantle xenoliths data [1] and has grown up of pyroxenite-peridotite cumulose

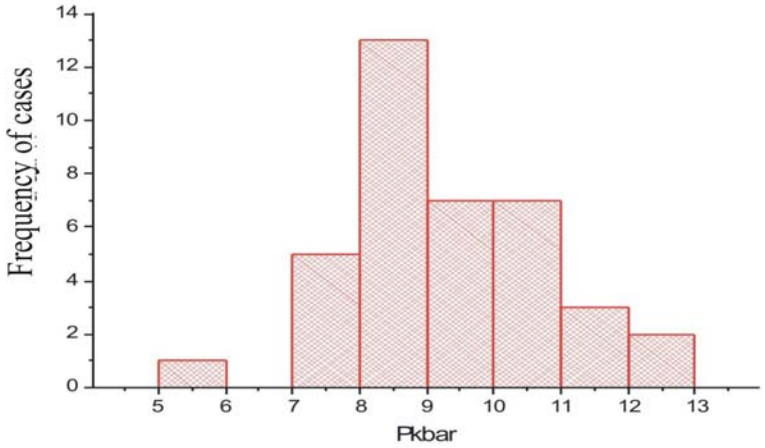

Fig. 2. Histogram of estimated pressures of magmas crystallization in the intermediate volcanic centers on the data of compositions of clinopyroxene impregnations.

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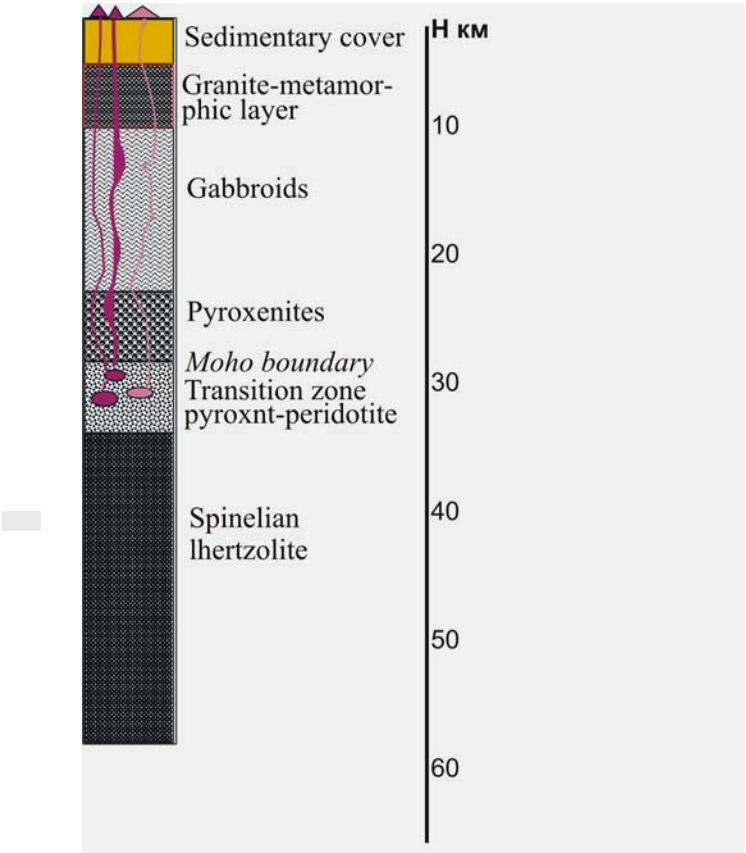

Fig. 3. Reconstruction of a plutonic section of the bottom crust and upper mantle of Northwest Spitsbergen on the geophysical data [1].

The generation of the original alkaline magmas was going on significant depths. It could be provoked by formation of a serial detachment faults on a direction continent - ocean (Crane et al., 1991) during rising of asthenospheric mantle and forming spreading zone – Knipovich Ridge. Probable the last skip of spreading axis in Late Miocene could initiate magmatic activity in continental border of Spitsbergen along released faulting zones. The Quaternary magmas of Spitsbergen are formed in continental situation with grades of enrichment composition and they could migrate to spreading zones in tern. As a result it was formation of low enriched asthenosphere that was marked on the isotope data for northern part of Knipovich Ridge [3].

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