

MINERALOGICAL-ISOTOPIC DYNAMICS, PHYSICO-CHEMICAL CONDITIONS AND STAGES OF SERPENTINIZATION PROCESS OF KIMBERLITES FROM YAKUTIA.

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Petrology of the serpentization of kimberlites based on the analysis of samples of more than 20 pipes from various kimberlite fields in Yakutia, is discussed. Petrographic, thermal, X-ray diffraction and spectral methods coupled with electron-scanning and transmission microscopy were applied to study kimberlites and serpentine minerals. Some zones of metasomatic transformation of kimberlites depending on the degree of serpentization, abundance ratio and mode of formation of different serpentine types together with associated secondary minerals are distinguished. A sequence of development of secondary mineral assemblages in these zones is as follows: 1) lizardite+chrysotile+magnetite; 2) lizardite+chrysotile+magnetite (up to 5-10%); 3) lizardite+chrysotile+calcite+magnetite+sulfides; 4) chrysotile+calcite+lizardite+magnetite+sulfides; 5) chrysotile+calcite+magnetite+sulfides. The chemical composition of secondary minerals depends on the sequential succession of zones. Microprobe analyses of lizardites (100 analyses) show appreciable CaO and Cl contents (0,29-1,04 wt.% and 0,98-1,07 wt.%, respectively). Lizardites of the intermediate zones are characterised by the highest Fe content (20-25%). Serpentes of such a composition represent the first occurrence in Yakutian kimberlites. During serpentization Fe/Fe+Mg ratios and MgO, CaO contents gradually increase from the first zones to the last ones. The composition of chrysotiles (> 200 analyses) of all studied zones of secondary transformation of kimberlites strongly differs from that of lizardites. A higher Mg/Mg+Fe ratio, high Al_2O_3 and low CaO, Cl

and MnO contents are characteristic of chrysotiles. With increasing degree of serpentization the Mg/Mg+Fe ratio and Al_2O_3 content of chrysotiles increase.

O, C, and Sr isotopic data indicate that chloride-calcic meteoric-hydrothermal waters derived from sedimentary rocks of the cover are responsible for the serpentine-carbonate mineralization of kimberlites. C and O isotopic compositions regularly change from light to more hard during serpentization.

Analysis of mineral-petrographic, isotopic-geochemical data coupled with thermodynamical computing permits estimation of the physico-chemical conditions of kimberlite serpentization. Acidity-alkalinity of the system varies from subacid reaction of solutions through alkaline and to neutral or acid one during the metasomatic transformation of kimberlites. At the first stages of kimberlite serpentization the solutions are characterized by a high partial CO_2 pressure and higher activity of calcium chloride, which result in intensive dissolution and following Mg accumulation in solutions. The low chemical activity of silicon is characteristic of kimberlite serpentization. The late episodes of magnesian metasomatism are characterized by low f_{CO_2} and high f_{O_2} and/or f_{S_2} values.

Kimberlite serpentization displays a well defined allochemical character. Behaviour of components such as Mg, Si, Al, Fe completely depends on the type and degree of serpentization. The increasing role of Mg removal with proliferation of kimberlite serpentization is the main chemical feature of the process. The total chrysotilization of kimberlites proceeds with an increase in the Si and Al chemical potential under high alkalinity of solutions. The Fe migration during kimberlite serpentization is regulated by the composition of fluid phase (f_{O_2} or

f_{S_2}) and by pH of the solution. The similarity and differences in serpentine mineralogy and physico-chemical conditions of the serpentinization of ultra-basic kimberlite inclusions are considered in details. Comparative characteristics of the kimberlite serpentinization and various genetic types of hyperbasites from the folded regions are presented.