ROLE OF SULFIDES IN THE EVOLUTION OF MANTLE ROCKS OF BASIC AND ULTRABASIC COMPOSITION AND IN THE EMERGENCE OF KIMBERLITE BODIES

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In kimberlite bodies sulfides occur in diamonds, in xenocrysts of garnet, olivine, zircon, pyroxene, ilmenite, chromespinel, in xenoliths of abyssal rocks of basic and ultrabasic composition and in kimberlite rocks themselves. Such heterogeneity is associated with the different stages in the evolution of mantle rocks and kimberlite melts. Sulfides are represented by magmatic, metasomatic and superimposed hydrothermal minerals. Sulfide nodules are developed in xenocrysts, diamonds and abyssal rocks have a complicated zonal structure. Core of nodules is composed either of quenched sulfide melt based on Fe and Ni or pyrrhotite and pentlandite in various combinations; internal part (outside the core) broken rim is composed of Co-containing pentlandite, external one - of chalcopyrite (Fig.I), sometimes with bornite or djerfisherite (Fig.2). The latter is encountered only in ilmenitic rocks.

In accordance with paragenesis of these minerals, diamond included, a regular evolution of the initial sulfide melt entrapped by minerals is traced (Fig.3). Composition of the initial sulfide melt in minerals of eclogitic paragenesis is extremely poor in Ni (less than 3 mass.%) and enriched with Fe (over 55 mass.%); in minerals of ultrabasic magnesian-ferriferous (ilmenite) series the amount of Ni is greater (from 2,5 to IO mass.%), while that of Fe is less (from 5I to 56 mass.%); in minerals of ultrabasic magnesian paragenesis the melt is substantially enriched with Ni (20-26 mass.%) and poor in Fe (34-40 mass.%).

For sulfide nodules from diamond and minerals in the relatively rich diamond pipes the availability of non-degraded monosulfide solid solution based on pyrrhotite is characteristic which gives evidence of the quenching conditions in the emergence of productive kimberlite bodies. The amount of sulfide inclusions presented in diamond of the ultrabasic paragenesis is much less than in diamond of the basic paragenesis.

Thus, at crystallization of diamond and mineral the basic and ultrabasic paragenesis there is a successive regular change in the composition of sulfide magmatic melts that have liquated as function of the paragenesis type, P-T conditions of crystallization of mineral association, and of the composition of the host mineral.

Polymictic sulfide systems of various mineral associations are described, and in all types of xenoliths of ultrabasic and basic rocks both in the form of inclusions in minerals and interstitial - in the intergranular space of minerals. Sulfide nodules in minerals of xenoliths are identical by chemical and phase composition with nodules of mineral insets in kimberlites in accordance with type of paragenesis. This fact evidences of the creation of mineral insets as a result of xenoliths disintegration.

Sulfide inclusions in the intergranular space of rock-forming minerals of xenoliths are subdivided into three types:
I. Nodules of pyrrhotite-pentlandite-chalcopyrite composition; 2. The same aggregates but with partial or full replacement of chalcopyrite by djerfisherite and monomineral inclusions of djerfisherite; 3. Oriented silicate-sulfide growths of irregular shape of pyrrhotite-pentlandite-chalcopyrite-olivine composition. The first is the typical example of primary-magmatic sulfide formations. In the second case formation of djerfisherite, very often in close association with amphibole and mica, is connected with the abyssal mantle metasomatosism under the influence of fluids rich in S and alkalies over rocks of basic and ultrabasic composition. As a rule, the above refers only to ilmenite rocks rich in K, Ti,Fe,Mg. Superimposed metasomatic mineral association is a much more recent formation. Formation of the third type sulfides is likely to result from disintegration of the basic rock-forming minerals crystallized from the residual silicate-sulfide melt. However, one must

not exclude that such oriented olivine-sulfide growths can be formed as a result of the S-rich kimberlite magma effect over xenoliths of abyssal rocks. Therefore, peculiarities of composition and structure of sulfide minerals are in close connection with the three basic stages in the evolution of ultrabasic rocks and eclogites in kimberlites.

In kimberlite rocks as themselves sulfides are widely developed as well, and are associated with the hydrothermal stage of kimberlite bodies formation. Most typical are as follows: scattered crystals of pyrite pyrite or pyrite-magnetite pseudomorphioses by olivine and diopside, pyrite-sphalerite-galenite-calcite veins. The latter sometimes form thick streaks at the boundary of different phases of kimberlite magmas intrusion. There are several generations of sulfide minerals according to the long-term evolution and multi-stage formation of kimberlite bodies.

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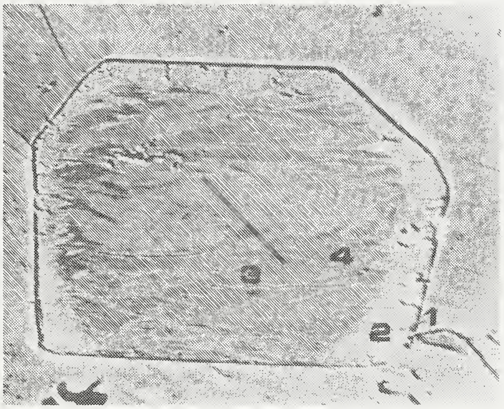
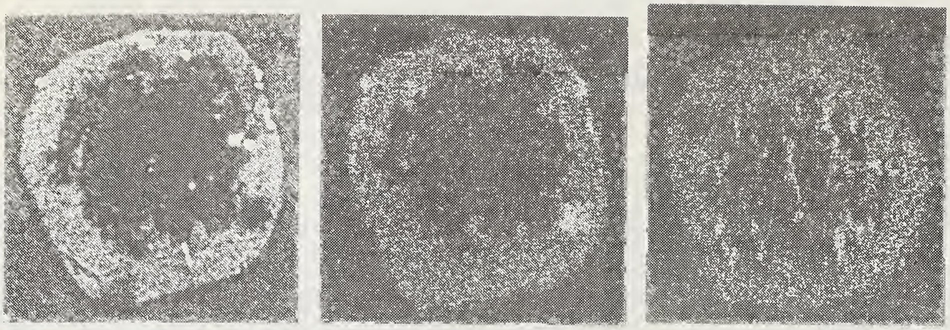
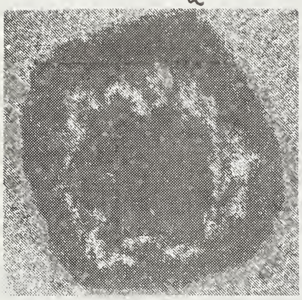


Fig.I. Poly-mineralic sulfide inclusion in zircon. External thin rim is composed of chalcopyrite (I), internal one - of Co-containing pentlandite (2). Core of nodule is unhomogeneous and composed of high nickel pyrrhotite (3) and poor nickel pyrrhotite (4). Back-scattered electron image with composition contrast 350^x



a - KK_α　　b - CuK_α　　c - NiK_α



d - MgK_α

Fig.2. Poly-mineralic sulfide-oxide inclusion in garnet-ilmenite peridotite. Core of nodule is composed of poor nickel pyrrhotite (I), internal rim (black Hun like)(2) - of Mg-silicate (serpentine?), external one - of djerfisherite (3), 300^x. a - back-scattered electron image + KK_α ; b - CuK_α ; c - NiK_α ; d - MgK_α

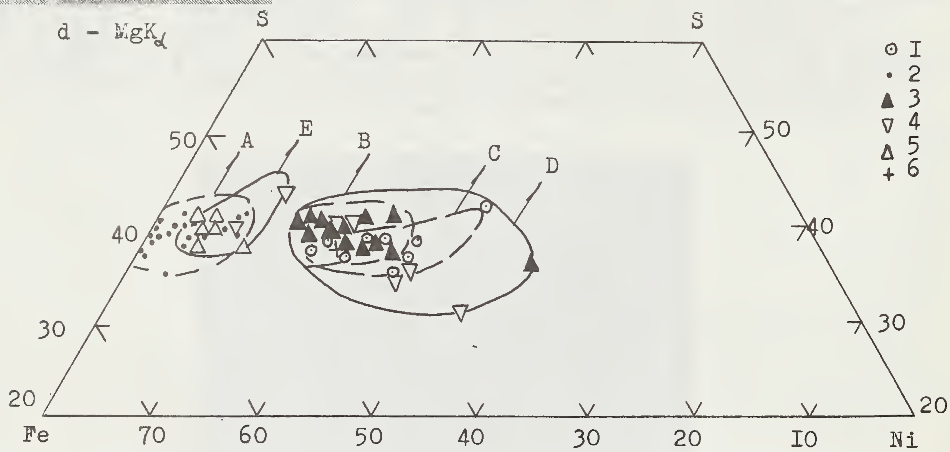


Fig.3. Calculated compositions of primary sulfide melts from inclisions in: I - diamonds of basic (eclogitic) paragenesis (by E.S.Efimova and N.V.Sobolev, I983); 2 - diamonds of ultrabasic paragenesis (by E.S.Efimova and N.V.Sobolev, I983); 3 - zircon (by V.K.Garanin et.al., I983); 4 - olivine (by I.P.Barashkov et.al., I98I); 5 - ilmenite (by Boctor and Boyd, I98I); 6 - garnet from ultrabasic (websterite) paragenesis. Lines outline fields of sulfide melt from: A - diamonds of eclogitic paragenesis; B - zircon of ultrabasic (magnesian) paragenesis; C - diamonds of ultrabasic (magnesian) paragenesis; D - minerals of ultrabasic magnesian series of rocks; E - minerals of ultrabasic magnesian-ferriferous series of rocks