ON THE ORIGIN OF FINE-GRAINED Ca,Al-RICH INCLUSIONS IN THE EFREMOVKA CARBONACEOUS CHONDRITE. A.A.Ulyanov. V.I.Vernadsky Institute of Geochemistry and Analytical Chemistry, USSA Academy of Sciences, Moscow, USSR.

Several Ca,Al-rich inclusions (CAI's) in the Efremovka chondrite (C3V) have recently been classified as Type F CAI's (1). We report here a further investigation of fine-grained CAI 's in the Efremovka. This new investigation is based upon detail microscopical study of mineralogical and texture featuries of several inclusions of Type F, one of which (E14) is described in this abstract.

CAI E14 is a broken piece (~1/4-1/3 part) of the larger protoinclusion. Macroinhomogeneity (change in the mineral composition and grain size) in E14 (Fig. 1) exhibits concentric zoning of the protoinclusion. The core of the protoinclusion is a very fine-grained aggregate of spinel (Sp) grains surrounded by anorthite (An) rim and immersed in pyroxene (Px) matrix. The size of Sp is not more than 10 μm. The mantle of protoinclusion consists of fine-to-medium grained aggregate of Sp-grains (10-15 μm) immersed in Px matrix and contents patches of irregular shape, which mineralogical association and grain size are similar to those of the core. Crust of the protoinclusion is a fine -to-medium grained aggregate of Sp, An, and Px. Its texture is similar to those of the core. Sharp increase of the grain-size for Sp (up to 30 μm) and appearance of small ( 1 μm) isometric crystals of perovskite (Pv) was found on the periphery of the inclusion crust. The protoinclusion is surrounded by broken Px rim. Similarity in the mineralogical and texture featuries of all the above-mentioned zones (except Px rim) suggests related mechanism of their formation under insignificant variations of the environment.

Detail study of texture in the protoinclusion crust indicates on double-pyroxene boundary, i. e. the contact of two spherulitic-like rims of Px around Sp and An grains. In several cases dark opaque matrix similar in appearance to common dark matrix carbonaceous chondrites is observed some vugs between the two pyroxene rims. The origin of these double pyroxene boundaries is difficult to explain by the direction crystallization of Px from the surfaces of Sp grains (sometimes with An rims) to the encounter front of crystallization of another Px rim of the neighbour Sp grains. The capture of this evidently low-temperature opaque matrix during the high-temperature crystallization of the protoinclusion seems still more unprobable. The individual Sp-An-Px aggregates were, probably, formed as independent objects in the gas-dust nebula, and then were accreted forming the protoinclusions, which were incorporated into the meteorite body. Such texture was observed in the protoinclusion crust only, but we suggest that other zones of the protoinclusion were formed by stickiness of small Sp-An-Px and Sp-Px bodies. Roundness of Sp-An-Px grains, sequence of crystallization of mineral phases (Sp→An→Px) and reaction relationship between Sp and An suggest that forming of the CAI's is due to crys-

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tallization of Ca,Al-rich liquid. However, absence of An rim in the mantle of CAI's is not compatible with phase relationship in the $CaO-MgO-SiO_2-Al_2O_3$-system (2). The origin of spherulitic -like rims of Px around Sp-An and Sp bodies is not dependent with crystallization of high temperature Ca,Al-rich melts but is a result of some other processes (e. g. condensation, gas metasomatism, and et al.).

Macroinhomogeneity of the protoinclusion may suggests a local chemical inhomogeneity in the early solar nebula, in some regions of which these small drops were formed. Subsequent crystallization and alteration of these drops were resulted in forming of Sp-An-Px, Sp-Px and Pv-Sp-An-Px microbodies. As a result of stickiness of these bodies their clusters were formed, agglomeration of which was resulted in formation of the core and the mantle of protoinclusions. Subsequence of cluster agglomeration is reflected in the macroinhomogeneity of the protoinclusion and probably did not depend on the time sequence, but is a results of spatial inhomogeneity in the gas-dust nebula. This cluster agglomeration is evidently correct only for the core and the mantle of protoinclusion. The crust of the protoinclusion was probably formed by subsequent stickiness of Sp-An-Px and Pv-Sp-An-Px bodies.

The data obtained for the largest available of Type F CAI (E14) of the Efremovka may be applied to other inclusions of this type in the same meteorite.

REFERENCES; (1) Ulyanov A.A., et al.(1982) LPS XIII, 813-814.
(2) Berezhnoy A.S. (1970) Mnogocomponentny sistemy okislov. Kiev."Naukova Dumka" (in russian)

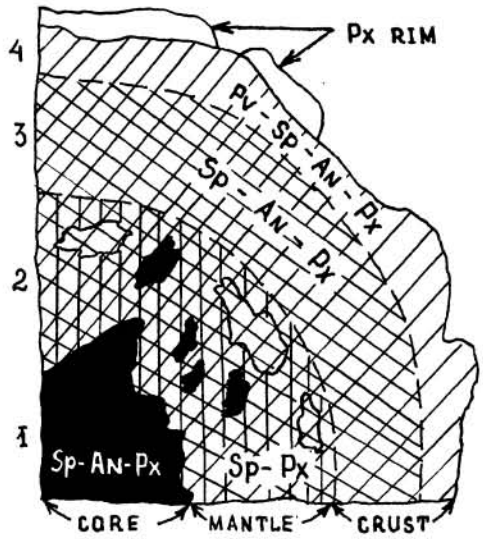


Fig. 1. Micromap of studied CAI E14 (scheme). Fine(1)-, fine-to-medium(2,3)-, medium(4)- grained textures.

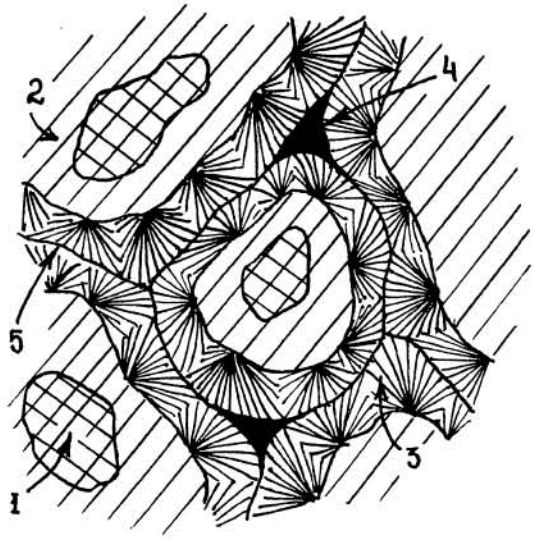


Fig. 2. Schematised representation of microtexture of CAI E14. Sp(1), An(2), Px(3), dark opaque matrix (4), and double pyroxene boundaries (5).