Khomyakov A.P. Synthesis of endemic minerals as a foundamental problem of theoretical and experimental mineralogy.

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The major attention in mineral typomorphism studies based on relationship of composition, structure, properties and physicochemical conditions is traditionally paid to the analysis of constitutional features of widely common ("through") minerals – quartz, feldspars, micas and others as main markers of natural mineral formation processes. Substantially less part is taken by minerals formed in unusual physicochemical conditions indicated by the presence of some little-distributed mineral types within the associations of a certain type. These are mainly endemic minerals known in individual deposits where they play the role of the main carriers of useful components in nontraditional types of mineral resources. The examples are the Lovozerskii and Ilimaussakskii massifs of the alkaline formation with their loparite lovozerite-murmanite and naujakasite-steenstrupine lujavrites that concentrate practically inexhaustible reserves of rare and radioactive elements, and also the natrite enriched nepheline syenites from the Khibin massif as the new potential type of the natural soda deposits.

Most endemic minerals with the limited occurrence, such as fersmanite $(Ca,Na)_4(Ti,Nb)_2Si_2O_{11}(F,OH)_2$ (Khibins) or naujakasite $Na_6(Fe,Mn)Al_4Si_8O_{26}$ (Ilimausakskii) do not contain any special chemical elements. Its endemicy is due to participation of some elements in rock and ore formation processes that do not compose the considered minerals but actively participate in the mentioned processes as natural catalyzors or inhibitors. Interesting is that most of discovered endemic minerals have no analogs though the phase diagrams with the fields of the corresponding compositions are studied in detail in experimental conditions. Based on paleomineralogical reconstructions performed by the author the catalytic role of phosphorus and inhibiting role of potassium in origin of murmanite, ussingite, and naujakasite as rock- and ore-forming endemic minerals in the most high-productive alkaline complexes was demonstrated. Close connection of endemic minerals with giant various mineral deposits determining the structure of national economics in many countries advances the task of their synthesis and study of the stability fields to the row of the most urgent problems of theoretical and experimental mineralogy.

Unsuccessful attempts to synthesize artificial analogs of many minerals reflects the basic difference between the natural and laboratory conditions, first of all the inaccessible for experimental studies multicomponent natural environment, geologic time duration as a factor contributing to formation of minerals with very narrow stability fields, participation of the complex combinations of components and phases (protominerals) the linking role of which (as structural standards, substrates, catalyzers, stabilizers) can be discovered by detail paleoreconstructions based on the heritage principle (Khomyakov, 1994; Khomyakov, Yushkin, 1981).

Thus, despite the entire study of hydrothermal phase formation in titanosilicate systems the murmanite artificial analog $Na_2Ti_2Si_2O_9$ $2H_2O$ taking an important part at tantalum - niobium reserve balance in the alkaline nepheline syenite massifs was not obtained so far. The detail the analysis of the available data showed that linking part of phosphorus compounds is necessary to synthesize this mineral. Murmanite is related to a special genetic group of transformation minerals that are not crystallized from melts or solutions unlike normal minerals, but form exclusively by pseudomorphism of other phases. The murmanite protophase is a phosphorus bearing lomonosovite $Na_2Ti_2Si_2O_9$ Na_3PO_4 being able to change easily in epithermal and supergene conditions irreversibly exchanging sodium phosphate for water molecules in the reaction: lomonosovite+H_2O→murmanite+Na_3PO_4.

Such minerals as epistolite, lovozerite, tisinalite, keldyshite being the products of dehydration and decationizing of vuonnemite, cyrsinalite, kazakovite and parakeldyshite, respectively, are related to the same genetic group of transformation types. As murmanite, the listed hydrated minerals cannot be obtained by a direct synthesis since their structural base is created in the certain physicochemical conditions, however, is passed from the minerals-predecessors to minerals-descendants in substantially different conditions. This is the originality of the heritage principle in mineral genesis.

The mineral polymorphism associated with epitaxy phenomenon can be a bright illustration of the universal role of the considered principle. Thus, the study of the findings of quite rare Na,Sr,REE-carbonate donnayite in Khibins showed that donnayite crystallizes in triclinic system during free growth, whereas the rhombohedral modification of this mineral with its own crystalline structure forms when overgrowing Sr-ewaldite in analogous physicochemical conditions.

References:

1. Khomyakov A.P. Systems of natural and artificial compounds as intersecting multitudes // Zap. Vsesoyuz. Mineral. o-va. 1994. V. 123. No. 4. PP. 40-43.
2. Khomyakov A.P. Yushkin N.P. The heritage principle in crystal genesis // Doklady AN SSSR. 1981. V. 256. No. 5. PP. 1229-1233.