Syntheses of rare K-titanates (yimengite, mathiasite and priderite) at high TP conditions: application to modal mantle metasomatism.

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Magnetoplumbite (yimengite-hawthorneite, HAWYIM), crichtonite (lindsleyite-mathiasite, LIMA) and hollandite (priderite) minerals are exotic titanate phases, which formed during metasomatism at the conditions of high alkali activity, especially K, in the fluids in the upper mantle peridotites. The paper presents data on experiments on formation of K-end-members priderite, yimengite and mathiasite, as the result of the interaction of chromite, chromite+ rutile and chromite+ ilmenite assemblages in the presence of a small amount of silicate material with $\text{H}_2\text{O}-\text{CO}_2-\text{K}_2\text{CO}_3$ fluids at 3.5 and 5 GPa and 1200°C. The experiments demonstrated the principal possibility of the formation of the titanates in the reactions of chromite with alkaline aqueous-carbonic fluids and melts. However, the formation of these phases does not proceed directly on chromite, but requires additional titanium source. The relationship between titanates is found to be a function of the activity of the potassium component in the fluid/melt. Priderite is an indicator of the highest potassium activity in the mineral-forming medium. Titanates in the run products are constantly associated with phlogopite. Experiments prove that the formation of titanates manifests the most advanced or repeated stages of metasomatism in mantle peridotites. Association of titanates with phlogopite characterizes a higher activity of the potassium component in the fluid/melt than the formation of phlogopite alone. The examples from natural associations, reviewed in the paper, well illustrate these conclusions. Experiments revealed the following features of crystallization of these phases and allowed interpretation of the titanate associations in metasomatized mantle peridotites.

1. The principal possibility of the formation of minerals of crichtonite and magnetoplumbite groups and priderite in the reactions of chromite with alkaline aqueous-carbonic fluids and melts is confirmed. Such substances are considered as main agents of potassium metasomatism, leading to the formation of titanates in the upper mantle (Konzett et al., 2013; Rezvukhin et al., 2018).

2. The formation of these phases does not proceed directly on chromite (e.g. Haggerty et al. 1983; Haggerty, 1983; Nixon, Condliffe, 1989), and requires additional titanium source. They are rutile and ilmenite, which are themselves usually are products of modal metasomatism of peridotites. This experimental fact demonstrates that the formation of titanates marks probably the most advanced or repeated stages of metasomatism in mantle peridotites.

3. This is also proved by the relationships of titanates with phlogopite. Association of titanates...
with phlogopite characterized by a higher activity of the potassium component in the fluid/melt than the formation of phlogopite alone. Such conditions can again be created at the most advanced or repeated stages of mantle metasomatism.

(4) The relationship between titanates is also a function of the activity of the potassium component in the fluid/melt. Priderite is an indicator of the highest potassium activity in the mineral-forming medium. The above examples from natural associations (Zhou, 1986; Konzett et al., 2013; Almeida et al., 2014) well illustrate this conclusion.