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Review

Physicochemical conditions of formation of hydrothermal titanium mineralization on the Murunskiy alkaline massif, western Aldan (Russia)

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ABSTRACT

The unique Aldan ore-magmatic province in Yakutia is characterized by Mesozoic alkaline magmatism and related ore deposits (Cu-Au porphyry, gold-quartz vein and gold-brannerite). The Murunskiy alkaline massif occurs in the western part of this province.

This massif includes the world's largest volcanic-plutonic complex of potassium-alkaline rocks and has no analogs in the world. High agpaitic indexes are common for all magmatic rocks of the massif. Moreover, the massif is well known for its unique Ba-Sr carbonatite and charoite rocks. We have studied the fluid regime of a post-magmatic formation of rutile and anatase-brookite quartz veins with pyrite, galena, sphalerite, chalcopyrite, native gold and the titanium mineralization. Fluid inclusions study shows that the titanium mineralization was formed at the temperature range of 475–440 °C and pressure between 150 and 125 MPa from heterogeneous chloride-carbonate-sulfate fluid. The immiscible fluid fractions were represented by gaseous phase, low- and middle-concentrated solutions, as well as highly concentrated salt brine. Mineral-forming fluids were characterized by high redox-potential, due to the high concentration of sulfates. The immiscible fluid fractions differ in the content of ore elements. Highly concentrated fluid fractions contain increased concentrations of S, Cu, Mo, Fe, Pb, Zn, U, and Au, and low-concentrated fluid fractions containing U, Th, As, and Au.

1. Introduction

Titanium mineralization represented by anatase, brookite and rutile crystals in hydrothermal quartz veins occurs only at the Murunskiy massif. In these veins vanadium, uranium and thorium minerals, sulfides and native gold are common. Studying the fluid regime of the hydrothermal ore formation at the Murunskiy massif is one of the important problems in revealing the factors governing the ore-bearing potential of alkaline massifs.

The Murunskiy massif consists of compositionally diverse alkaline rocks: from alkaline ultramafic rocks to alkaline granites with all intermediate varieties included (Vladykin, 2009). The study of melt inclusions in the minerals of olivine-monticellite rocks from the Murunskiy massif revealed the carbonate–silicate liquid immiscibility at the high-temperature magmatic stage (1280–1260 °C). In addition, melt inclusions demonstrate the evolutionary pathways of parental alkaline-ultramafic magmas from silicate melts to carbonate-sulfate-phosphate salt melt fractions (Panina and Motorina, 2008). The further evolution of salt and silicate-salt magmatic melts generated by parental alkaline magmas might have led to the generation of metal-bearing hydrothermal fluids, which could take part in the formation of post-magmatic and hydrothermal ore deposits associated with alkaline magmatism (Bilibina et al., 1963; Maximov et al., 2010; Borisenko et al., 2011). Physicochemical parameters and the metal-bearing potential of fluids generated during the formation of K-alkaline massifs can be obtained by studying the fluid regime of various postmagmatic mineralization in the Murunskiy alkaline massif, including quartz veins with REE-titanium and sulfide mineralization.

2. A brief geological outline

2.1. Geology of Murunskiy massif

The Murunskiy massif is located to the west of Aldan (northeast of the Irkutsk region), which borders Yakutia (Fig. 1). It consists of two large outcrops of Mesozoic alkaline rocks, known as Big Murun and Small Murun massifs. A relatively small alkaline granite massif – Kedroviy stock located to the southeast of these large massifs, also belongs

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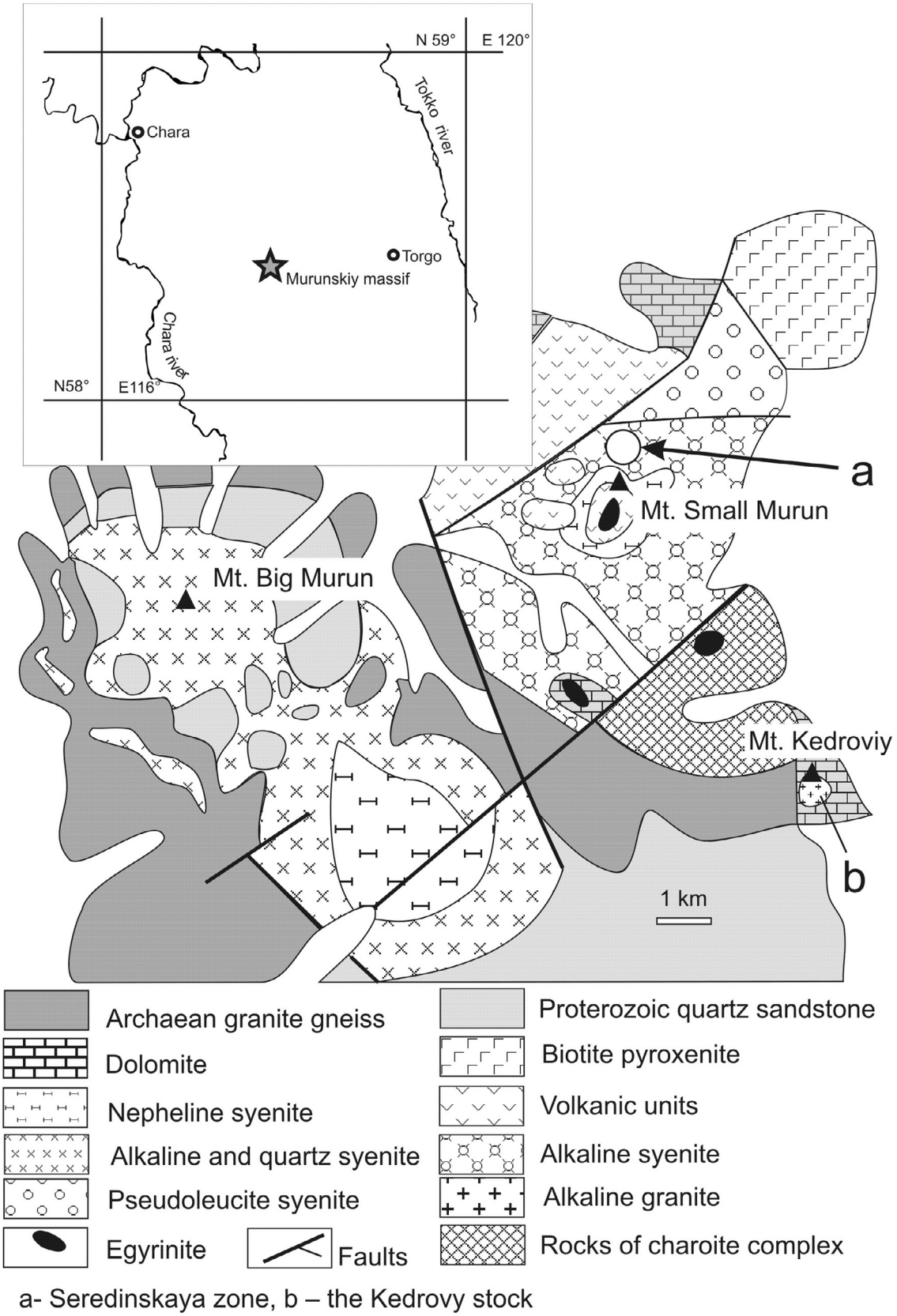

Fig. 1. Simplified geology of the Murunskiy alkaline massif Vladykin (2009).

to the magmatic rocks of the Murunskiy massif. The total outcrop area of alkaline rocks is about 150 km^2. The age of the massif was previously reported as 145 Ma (Vladykin, 2009). The geochemical and isotopic data suggest a deep-seated EM-1 source for the Murunskiy massif (Vladykin, 2009). The following model of the magmatic system was proposed for this massif (Vladykin, 2009):