Ore Geology Reviews 65 (2015) 761–778

Contents lists available at ScienceDirect

Ore Geology Reviews

journal homepage: www.elsevier.com/locate/oregeorev

Differentiated rare-element mineralization in an ongonite–topazite composite dike at the Xianghualing tin district, Southern China: An electron-microprobe study on the evolution from niobium–tantalum-oxides to cassiterite

Fang-Fang Huang [a], Ru-Cheng Wang [a,*], Lei Xie [a], Jin-Chu Zhu [a], Saskia Erdmann [b], Xu-Dong Che [a], Rong-Qing Zhang [a]

[a] State Key Laboratory for Mineral Deposits Research, School of Earth Sciences and Engineering, Nanjing University, Nanjing 210023, China
[b] Université d'Orléans, CNRS/INSU, ISTO, BRGM, UMR 7327, 1A Rue de la Férollerie, 45071 Orléans, France

ARTICLE INFO

Article history:
Received 2 April 2014
Received in revised form 17 August 2014
Accepted 20 August 2014
Available online 30 August 2014

Keywords:
Ongonite
Topazite
Niobium–tantalum-oxides
Cassiterite
Nb–Ta–Sn mineralization
Fluorine
Fractional crystallization
Liquid immiscibility

ABSTRACT

Our study characterizes in detail the mineralogical, textural and compositional features of a highly evolved, composite ongonite–topazite dike and its magmatic differentiation history. We present compositional data collected by established techniques, i.e. by electron microprobe and wet-chemical analysis, which provide a detailed framework for future studies that employ state-of-the-art analytical techniques. The studied dike (referred to as the No. 431 dike) crops out within the Xianghualing area in the Nanling Range of southern China, in close spatial association with Jurassic Sn–Nb–Ta granite plutons. The rock samples in the No. 431 dike were collected from a structurally lower drill hole and a trench at higher level. The ongonite is encountered throughout the dike, but the topazite is only revealed along the margin of the upper, near-surface dike. The results of whole-rock major and trace element analyses show that the rocks of the No. 431 dike are strongly peraluminous with an average ACNK value of ~1.5 for ongonite and >3.9 for topazite. They are enriched in F, 1.7 wt.% and 5.4 wt.% on average for ongonite and topazite, respectively. The rocks have low Zr/Hf and Nb/Ta ratios, and high levels of ore-forming elements including Nb, Ta, Sn, and W. Silicate and oxide mineral assemblages, textures, and compositions are also distinct for the two rock types studied. In the lower ongonite of the dike, there are abundant phenocrysts of K-feldspar, quartz, and albite, and microphenocrysts of topaz and zinnwaldite in a matrix dominated by quartz, K-feldspar, and albite. Characteristic oxides are columbite–tantalite, tapiolite, and microlite, but cassiterite is absent. The upper ongonite of the dike has a silicate assemblage similar to the lower ongonite; columbite-(Mn), uranomicrolite, and limited amounts of cassiterite are the dominant accessory minerals. The topazite is characterized by large amounts of topaz and zinnwaldite intergrown with quartz, while K-feldspar, albite, and quartz phenocrysts have rounded shapes and are relatively rare. Cassiterite is the most abundant ore mineral, while Nb–Ta oxide minerals are less abundant. We interpret the whole-rock compositional trends, mineral textures, assemblages, and compositions to reflect the differentiation of an evolved, initially homogeneous magma that separated into aluminosilicate and hydrosaline melts, corresponding to crystallization of ongonite and topazite, respectively. The crystallization of Nb–Ta- and Sn-bearing ore minerals was strongly controlled by the separation of the two melt phases. We hypothesize that dike propagation/widening subsequent to the initial dike emplacement may have driven the separation of the aluminosilicate and hydrosaline melt phases that crystallized to ongonite in the core and topazite along the margins of the structurally higher part of the dike.

1. Introduction

Ongonite and topazite, described frequently in the 1970s (Eadington and Nashar, 1978; Kovalenko et al., 1971, 1975), are two unusual types of felsic rock that are rich in rare elements. They are characterized by volcanic to shallow-intrusive textures, and abundant volatile-rich minerals (mainly topaz). Ongonite is defined as the phenocrystic subvolcanic analogue of granite that is rich in the rare elements Li and F (Kovalenko and Kovalenko, 1976). Topazite has been used in reference to felsic dikes that consist mainly of quartz and topaz, for which mineralogical, textural, and field relationships suggest a magmatic origin (Eadington and Nashar, 1978). Mineralization associated with these two particular types of rock has been described from many localities

* Corresponding author at: School of Earth Sciences and Engineering, Nanjing University, 163 Xianlin Avenue, Nanjing 210023, China. Tel: +86 25 89680877, fax: +86 25 83686016.
E-mail address: rcwang@nju.edu.cn (R.-C. Wang).

http://dx.doi.org/10.1016/j.oregeorev.2014.08.008
0169-1368/

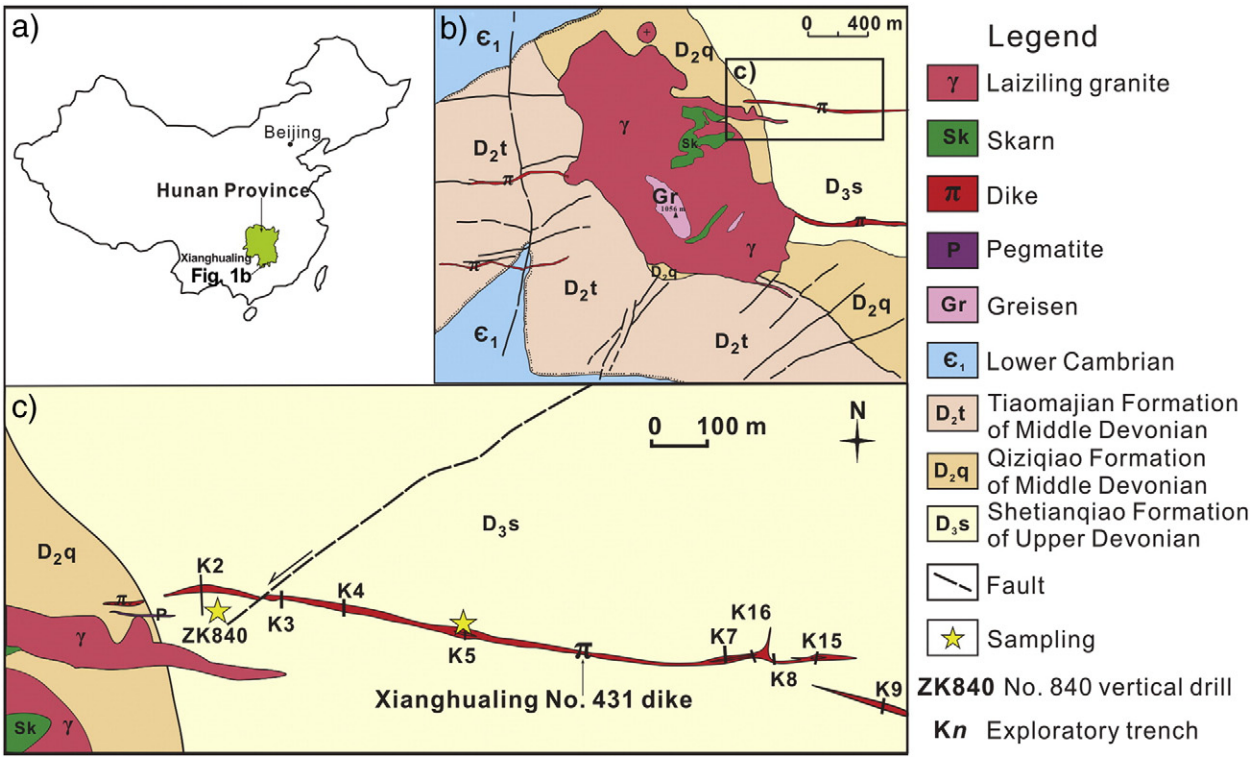

Fig. 1. Simplified geological map of the No. 431 dike, Hunan Province, South China. (a) Location of Hunan Province in China; (b) the No. 431 dike in close spatial association to the ~154–155 Ma Laiziling granite; and (c) the No. 431 dike sharply intrudes into carbonate-dominated strata.
Modified after Zhu et al., 2011.

worldwide. Examples include W deposits associated with F-rich rhyolites (ongonites) from Ongon Khairkhan, Mongolia (Štemprok, 1991), the type locality of topaz rhyolite with W, Nb, Ta, and Sn mineralization (Burt, 1992), similar to topaz-albite granite, e.g., Limu in Southern China (Zhu et al., 2001), the French Massif Central (Cuney et al., 1992), Southern New Brunswick, Canada (Taylor, 1992), and the Eastern Desert, Egypt (Helba et al., 1997). The mineralization associated with topazite in Southern China is complex but dominated by Sn, such as deposits at Shicheng, Xunwu, Huichang, Yanbei and Taishun (Liu et al., 1996).

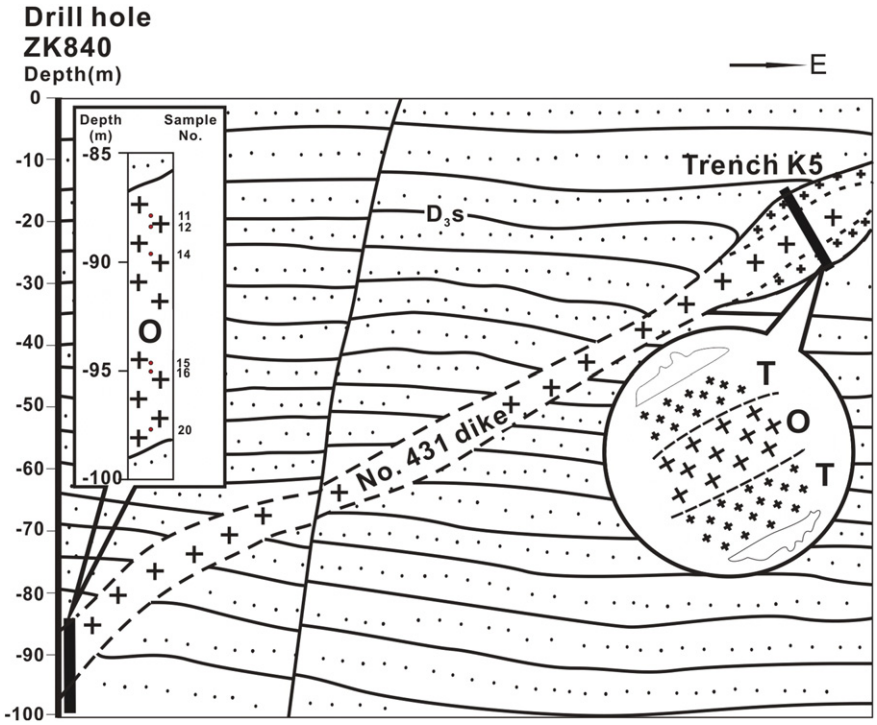

Fig. 2. Cross-section of the No. 840 vertical drill hole and the No. 5 trench across the No. 431 dike. Abbreviations: O: ongonite; T: topazite.