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Magmatic and hydrothermal Ta-Nb oxides in the marginal pegmatite at the Yichun deposit, SE China

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The Yichun deposit, located in Jiangxi Province of SE China, is currently mined by open-pit methods for Ta, Nb, and Li. It hosts more than 11 Kt of Ta, at an average grade of 0.02 wt % Ta_2O_5. Previous research has focused on the topaz lepidolite granite (TLG) that hosts most of the minable Ta, whereas the unmined marginal pegmatite (MP) that lies at the roof of the TLG has received little attention.

The MP is a tabular granitic pegmatite that is approximately 96, 000 (400×60×4) m^3 in volume. It is internally zoned, and Ta-Nb oxides occur disseminated only in an aplite unit and an intermediate zone (IZ), where the aplite occurs in horizontally banded layers within the IZ. In examining the MP, we discovered texturally unusual assemblages of Ta-Nb oxides. Specifically, the principal Ta-Nb phases in the aplite are columbite-group minerals (CGM) and wodginite-group minerals (WGM) that are approximately equal in abundance. WGM occur as alteration products of, or overgrowths on, CGM. In the former, WGM occur as irregular patches or zones that surround and penetrate CGM. In the IZ, the only Ta-Nb phase is an acicular variety of columbite-(Mn) that occurs as aggregates in an assemblage of molybdenite + columbite-(Mn) + lepidolite + fluorapatite + uraninite + zircon + native bismuth (listed in order of approximate decreasing abundance). Most of this acicular columbite-(Mn), and the associated minerals, are hosted by quartz that is interstitial to coarse triplite ($(Mn, Fe)_2(PO_4)(F, OH)$). Rarely, this unique mineral assemblage is hosted by fluorapatite veins that crosscut triplite. Quartz crystals that host these acicular CGM, enclose abundant primary melt and fluid inclusions that were trapped together.

The aplite-hosted CGM have similar major-element chemistry to magmatic CGM in the TLG, and are characterized by molar Ta/(Nb + Ta) ratios and Mn/(Mn + Fe) ratios that range from 0.17 to 0.86, and from 0.92 to 0.95, respectively. The IZ-hosted columbite-(Mn) exhibits a restricted range of Ta/(Nb + Ta) ratios, from 0.22 to 0.31, but a relatively wide range of Mn/(Mn + Fe) ratios, from 0.59 to 0.80. The aplite-hosted CGM are richer in Fe and Mo than most TLG-hosted magmatic CGM, although they are characterized by comparable concentrations of Li, Rb, Cs, Zr, Hf, W, U, Y, and Bi. Some aplite-hosted CGM exhibit regular compositional zoning, where the rim generally contains higher Hf and Mo, but lower Li, Ti, Fe, Zr, W, and U concentrations, than the core. Such core-to-rim chemical variations are similar to the TLG-hosted magmatic CGM. The acicular IZ-hosted CGM contain higher and more variable concentrations of not only Fe, but of the high-field-strength elements, than both the TLG-hosted and the aplite-hosted CGM.

The textural, mineralogical, and chemical characteristics of Ta-Nb oxides indicate the occurrences of both magmatic and hydrothermal Ta-Nb phases in the MP. The presence of both primary melt and fluid inclusions in quartz that hosts acicular IZ-hosted CGM suggests that these

acicular crystals grew close to the magmatic-hydrothermal interface, but most likely crystallized from an aqueous fluid.