COMPOSITIONAL CONSTRAINTS ON A MODULAR SERIES OF Bi-Pb TELLUROSULPHIDES

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Compounds containing essential Bi, Pb, Te and S are rare in nature. Aleksite, PbBi$_2$Te$_2$S$_2$, is known from a mere half dozen localities worldwide, and the single other recognized mineral, saddlebackite, Pb$_2$Bi$_2$Te$_2$S$_3$, is known only from two localities (Boddington, W.A.; Kochkar, S. Urals, Russia). Investigation of complex sulphosalts-telluride assemblages from Iilijärvi, SW Finland, a satellite deposit within the Orijarvi orefield, reveals additional, unnamed members of this group with compositions approximating to Pb$_5$Bi$_4$Te$_4$S$_7$, Pb$_6$Bi$_4$Te$_4$S$_8$ and Pb$_7$Bi$_4$Te$_4$S$_9$. These occur as fine intergrowths, rarely as larger single lamellae, also with aleksite, within a matrix of giessenite, galena and cosalite. The samples contain abundant gold, seen also as symplectic intergrowths with rutile. Another unnamed phase, "phase C" (PbBi$_4$Te$_4$S$_3$), had earlier been recognized as homogeneous grains and lamellar intergrowths within an assemblage consisting of aleksite, tellurobismuthite and Pb-bearing tetradymite from St. David’s Mine, Clogau, Wales, U.K. Reinvestigation of this assemblage, including careful microanalysis to avoid sub-µm scale intergrowths of the phase with aleksite, allows determination of chemistry. The compositional dataset from both occurrences allows us to propose a series of minerals derived from tetradymite, with the general formula Pb$_N$Bi$_4$Te$_4$S$_{N+2}$. Tetradymite, i.e. Bi$_4$Te$_4$S$_2$, has N=0, phase "C" has N=1, aleksite N=2, saddlebackite N=4 and the phases from Iilijärvi, N values of 5, 6 and 7. A natural phase with N=3, i.e. Pb$_3$Bi$_4$Te$_4$S$_5$, has not been found in nature. However, "phase C", aleksite, Pb$_3$Bi$_4$Te$_4$S$_5$ and saddlebackite (N=1,2,3,4) have previously been reported as products (Phases D,E,F,J) in synthetic experiments at 500°C; Pb$_5$Bi$_4$Te$_4$S$_7$, Pb$_6$Bi$_4$Te$_4$S$_8$ and Pb$_7$Bi$_4$Te$_4$S$_9$ were not syn-
thesized. Although structural determinations on the new natural phases are needed, lamellar banding, with galena and tetradymite and extended compositional fields, observed in both sample suites can be compared to similar issues in Bi-sulphosalt series. This suggests that we may be looking at a modular, possibly polytypic series, based around modules of Bi₂Te₂S and PbS. We speculate that lattice-scale stacking disorder, as recognized in sulphosalts, may explain the extensive compositional fields. So far, this series appears exclusive to Au-deposits hosted within metamorphic terranes, further emphasising the significance of Bi-tellurides and related phases as monitors of the evolution of mineralisation and fluid character, since their stabilities are highly constrained by principal fS₂-fO₂ buffers.