Atomic-scale imaging of mixed-layer compounds from the aleksite group

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Bi-Pb-chalcogenides of the aleksite group, $Pb_nBi_4Te_4S_{n+2}$ [1] represent a homologous modular series. Named minerals (aleksite, $PbBi_2Te_2S_2$, and saddlebackite, $Pb_2Bi_2Te_2S_3$) are thus considered as unit cell based on regular stacking of 7- and 9-atom modules: ($Bi_2Te_2S{\cdot}PbS$) and ($Bi_2Te_2S{\cdot}2PbS$), respectively. The phases can also be defined as mixed-layer compounds with 1-dimensional interface modulated structures expressed by the general formula: $M_{p+\varepsilon}X_{p+1}$ (M=Pb, Bi; X= Te, S, Se; p>2; ε<1) [2]. Phases with ε=0, including aleksite, consist of a single type of layer, whereas phases with ε≠0 can be predicted as combinations of shorter and longer layers $S(M_pX_{p+1})$. $L(M_{p+1}X_{p+2})$; S, L=number of layers). An example is M_5X_7 ($M_{2.14}X_3$, 2<p<3) expressed as [57] repeats known as 'Phase C', $PbBi_4Te_4S_3$ [1]. HAADF-STEM imaging of FIB-prepared foils offers: (i) direct visualisation of these structures; and (ii) assessment of stacking disorder at the lattice scale that can produce non-stoichiometric compositions at the scale of the microprobe beam. HAADF-STEM images of Phase C (Clogau Mine, UK) show irregular layer stacking 5-, 7-, 9-, 11- and 13-atom layers (Fig. 1). TEM-STEM mapping of the sequence shows Pb and S present only within wider layers whereas the 5-atom layers are Bi- and Te-only. This suggests observed stacking disorder is related to an overprint of earlier Bi-Te assemblages.

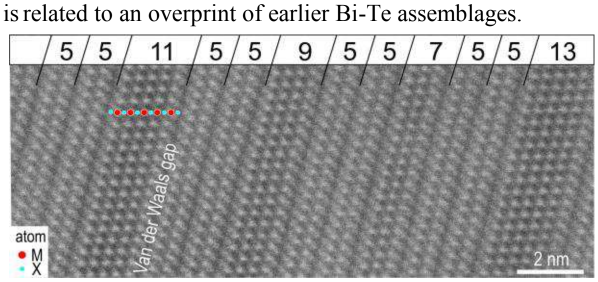

Figure 1. HAADF-STEM image of unnamed $PbBi_4Te_4S_3$. Image at 200kV (Titan Themis; Adelaide Microscopy).

[1] Cook, N.J. et al. (2007) Can. Mineral. 45, 417-435. [2] Ciobanu, C.L. et al. (2009) Am. Mineral. 94, 517–534.