

sectional groups of the two individuals, in their respective orientations, obtained across a plane which corresponds to the composition plane of the twin.

The second case needs the use of *lattice complexes*, which are types of crystallographic orbits generated by atoms in a crystal structure under the action of the symmetry operations of the space group.

When part of the atoms of an individual of a twin have a continuation across the twin interface, the individuals have a substructure in common, which corresponds to a lattice complex. If a crystal structure is composed of lattice complexes some of which have an eigensymmetry higher than the space group, these can be invariant under the action of the twin operation(s) and govern thus the formation of the twin.

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Non-MDO 4-layer Ferrophlogopite from Ruiz Peak (New Mexico). Massimo Nespolo^a, Isabella Pignatelli^a. ^aCRM² UMR-CNRS 7036, Institut Jean Barriol, Nancy-Université, France.

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In this study we investigated a crystal of ferrophlogopite from a rhyodacite lava flow at Ruiz Peak (New Mexico), belonging to the same rock hand specimen previously investigated by Ross et al. [3]. The analysis of the single-crystal X-ray diffraction pattern, obtained with an Oxford SuperNOVA microsource using CuK α radiation, shows four reflections in the 1/10 Å⁻¹ period of the 1M basic structure along the non-family rows: the crystal is thus a non-MDO 4-layer polytype. The cell parameters are $a = 5.3194(3)$ Å, $b = 9.2107(5)$ Å, $c = 39.828(5)$ Å, $\alpha = 90^\circ$, $\beta = 92.537(5)^\circ$, $\gamma = 90^\circ$. The stacking sequence has been obtained by PID analysis [4] and it can be expressed by RTW symbols $2 \bar{2} 22$ [3], Z symbols 1353 [7] and OD symbols 2040 [2] in the homo-octahedral approximation. It is the first time that this polytype is found in the Ruiz Peak sample, although it was discovered in a Ti-biotite by means of oblique-texture electron diffraction [6] and indicated with the $4M_3$ Ramsdell symbol. The atomic coordinates of the structural model have been obtained from those of the 1M polytype from the same sample, by applying the PID stacking vectors. The space-group type, as obtained from the stacking sequence, would be $C2/c$, but the intensities distribution reveals a triclinic structural symmetry. This lower symmetry can be due to the desymmetrization of the OD layers and/or to the cation ordering in the octahedral sheets [1]. $C2/c$ is therefore the maximal space-group type for this polytype whereas the correct space-group type is a triclinic *translationengleiche* subgroup of it. Consequently the Ramsdell symbol $4M_3$, previously used to indicate this stacking sequence [3, 5, 6], should actually be modified

in 4A to take into account the structural symmetry. The structural refinement is in course and the preliminary results confirm the stacking sequence obtained by PID analysis.

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The Misfit Layer Structure of Franckeite. Emil Makovicky^a, Václav Petříček^b, Michal Dušek^b, Dan Topa^c. ^aUniversity of Copenhagen. ^bCzech Academy of Sciences Prague. ^cUniversity of Salzburg.

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Franckeite from San Jose, Bolivia, nominally $Pb_{4.6}Ag_{0.2}Sn_{2.5}Sb_2Fe_{0.8}S_{12.6}$, consists of alternating pseudo-hexagonal (H) and pseudotetragonal (Q) layers. The triclinic crystal structure has a pronounced one-dimensional transversal wave-like modulation and a non-commensurate layer match in two dimensions. The Q layer is an MS layer (M=Pb, Sn²⁺, Sb.), four atomic planes thick, with a 5.820 Å, b 5.872 Å, and the layer-stacking vector c 17.367 Å. The lattice angles are α 94.98°, β 88.43°, γ 89.97°; the modulation vector $q = 0 a^* + 0.1286 b^* - 0.0284 c^*$. The H layer is a single-octahedral MS₂ layer (M = Sn⁴⁺, Fe.) with a 3.672 Å, b 6.275 Å, c 17.447 Å, α 95.25°, β 95.45°, γ 89.97°; the modulation vector is $q = 0 a^* + 0.1374 b^* - 0.0304 c^*$. Length of the modulation vector is 45.67 Å; the match of centred (sub)cells in this b direction, 15.5 Q : 14.5 H, occurs at 91.00 Å, a double of the modulation vector plus a structurally important difference $\Delta = 0.34$ Å. The a and b vectors of both subsystems are parallel; the c vectors diverge. 5D superspace refinement was performed in the superspace group C-1, using 7260 observed reflections. It resulted in the overall R(obs) value equal to 0.113. The Q layers are composed of two tightly-bonded double-layers, separated by an interspace hosting lone electron pairs. Average composition of cations on the outer surface was refined as $Pb_{0.9}(Sn,Sb)_{0.1}$ whereas that of cations covering the interspace with lone electron pairs, with a typical configuration analogous to that observed in orthorhombic SnS, corresponds to $Sn(Sb)_{0.64}Pb_{0.36}$. Iron is dispersed over Sn⁴⁺ sites in the H layer. Franckeite does not form cylindrical aggregates (as does related cylindrite) because of the increased thickness of the Q layer.

Keywords: modulated structure; misfit layer structure; Pb-Sn-Sb-Fe sulphide; franckeite