Magnetic order in the new 2D frustrated compound $Pb_3TeCo_3P_2O_{14}$

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The piezoelectric, optical and dielectric properties of the langasites have been studied in immense detail due to their practical and engineering applicability. However, these systems are also interesting from a fundamental perspective due to their having two geometrically frustrated sublattices: a large distorted kagomé network that can be occupied by rare-earth ions and a 2D array of isolated equilateral trimers. The dugganite subgroup (Te^{6+}-containing) of the langasite has allowed researchers to extend the variety of magnetic ions that may be placed on the latter sublattice from Fe, to Co, Mn, Ni, and Cu.

It was discovered that $Pb_3TeCo_3V_2O_{14}$, a dugganite where Co^{2+} occupies the sites that compose the trimer sublattice, has two antiferromagnetic transitions at zero-field – making it the only langasite discovered thus far to exhibit this behaviour [1]. Here, we prepared structurally analogous materials $Pb_3TeCo_3V_{2-x}P_xO_{14}$ (x=0.5, 1, 2) and found two peaks in the DC-magnetic susceptibility (not shown) at T_{N1}=12 K and T_{N2}=6.5 K for the x=2 material (similar transitions for the other materials as well). Using the C2 instrument at Chalk River laboratories, it was shown that antiferromagnetic ordering appears below T_{N1}. Unlike the analogous V^{5+}-containing (x=0) dugganite, no apparent changes occurring below T_{N2} were observed. Furthermore, while the magnetic unit cell of the x=2 material could be fully indexed to the first antiferromagnetic unit cell of the x=0 material, a different magnetic unit cell occurs for the partially doped materials that could not be indexed at this time (Figure 1). The full experimental details and analysis are outlined in [2, 3].

References:

[1] Silverstein *et al.* (2012) Chem. Mater. **24**, 664-670.
[2] Krizan *et al.* (2013) J. Solid State Chem. **203**, 310-320.
[3] Silverstein *et al.* (2013) J. Phys. Condens. Matter **25**, 246004.

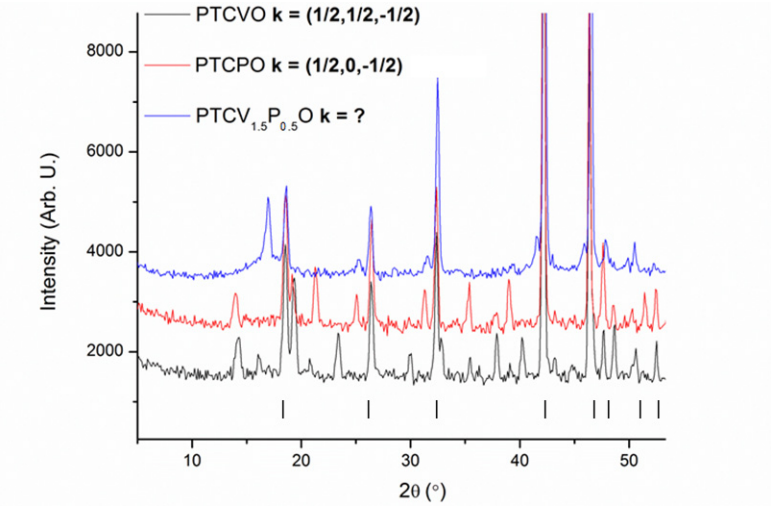

Figure 1: Neutron diffractogram depicting the second antiferromagnetic unit cell of $Pb_3TeCo_3V_2O_{14}$ (PTCVO, lowest black curve, T=4 K), $Pb_3TeCo_3P_2O_{14}$ (PTCPO, middle red curve, T=7 K, same magnetic unit cell as PTCVO at this temperature) and $Pb_3TeCo_3V_{1.5}P_{0.5}O$ ($PTCV_{1.5}P_{0.5}O$, top blue curve, T=7 K). Black tick marks denote structural Bragg peaks.