The Abancay Batholith, Late Eocene Crustal Thickening, Multiple Mixing-Differentiation Cycles, and Porphyry Cu-Au Mineralisation on the Altiplano at Antapaccay, Southern Peru

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This study, the first petrochemical account of Peru's second largest plutonic complex, the Abancay Batholith, focusses on the petrogenesis of intrusions associated with mineralisation at the Antapaccay porphyry Cu-Au deposit, that record the 9 m.y. magmatic history from 41.5 to 32.2 Ma and were emplaced before, during and after the Incaic compressive event that was associated with the transition from normal to flat-slab subduction in the CVZ from Late Eocene to Early Oligocene time.

The Abancay Batholith and Antapaccay suite are calc-alkaline, with distinctive high Na-Al-Ca-Sr-V and low K-Ti-Y-Yb-Zr chemistry, and range from hornblende gabbro cumulates, through diorites to granodiorites. The mineral assemblage, mineral chemistry, and whole rock chemistry indicate the system was hydrous, oxidised and saturated with SO_2. Compositionally diverse amphibole phenocrysts, inversely zoned plagioclase phenocrysts, and resorbed quartz and plagioclase phenocrysts, suggests magma mixing occurred during differentiation. Whole rock geochemistry indicates four cycles of differentiation and 'back-mixing' of successive, evolved residual melts with a common high-Mg, hydrous, basaltic andesite 'parental' melt. Fractionation was hydrous and dominated by hornblende.

Al-in-hornblende barometry shows that the magma differentiated at a wide range of pressures that correspond to a lower crustal 'hot zone' at 31-35 km depth, a mid crustal magma chamber at 19-28 km depth, and the final level of emplacement in the upper crust at 7-14 km. Hornblende-plagioclase thermometry, and magnetite-ilmenite Fe-Ti exchange thermometry and oxygen barometry show that oxygen fugacity increased with temperature relative to the FMQ buffer, a consequence of magma mixing. Increasing sulfate in apatites from successive intrusive phases demonstrates the role mafic recharge plays in increasing the volatile content in porphyry productive magmas.

Magmatism associated with porphyry Cu-Au mineralisation at Antapaccay was coincident with a period of rapid crustal growth of more than 10 km in thickness in less than 2-3 my, to create a proto-Altiplano with ~58 km thick crust in the Late Eocene. The horizontal compressive stress responsible for crustal thickening trapped hydrous magmas at depth where they obtained metallogenic fertility by multiple cycles of mafic recharge and differentiation dominated by hornblende.