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Petrological characteristics of Plio-Quaternary 'Sencca' Ignimbrites, Western Cordillera of the Central Andes in Peru

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Large-volume ignimbrite deposits have been emplaced between 24.6 and 1.37 Ma in the western Andean Cordillera of Southern Peru. The ignimbrites older than 9 Ma (Nazca, Alpabamba, Huaylillas and Caraveli ignimbrites) have formed plateaus, whereas the deep valleys incised in plateaus have been filled by younger Lower-Upper Sencca (∼5– 2 Ma) and Las Lomas ignimbrites. Among the younger valley-filling units, Lower and Upper Sencca ignimbrites, with intercalated Upper Barroso lavas, have probably originated from a source beneath the Nevado Coropuna volcano. The unwelded-to-loose, crystal-poor pumice flows of Las Lomas unit (c.1.56-1.37 Ma) can be readily distinguished in the field from the rhyolitic Sencca ignimbrites. In contrast, discriminating Lower Sencca from Upper Sencca deposits in the field is difficult due to comparable lithofacies characteristics. Such a distinction is, however, essential in order to determine temporal constraints on valley incision.

The Lower Sencca compound ignimbrite sheet is more widespread (∼800 km2) than the Upper Sencca ignimbrite sheet (∼600 km2). The Lower Sencca ignimbrites usually form terraces hanging on valley sides but Upper Sencca form deposits crop out near the present valley bottoms or in shallow valleys on high plateaus around Barroso volcanoes. The Lower Sencca ignimbrite is composed of multiple cooling units with a crystal- and fiamme-rich vitrophyric base, overlain by strongly welded, eutaxitic subunits towards the top. Uppermost subunits exhibit an indurated ash and pumice rich vapour-phase facies. The Upper Sencca ignimbrite sheet comprises two subunits only: (1) the basal, black vitrophyre, overlain by a fiamme- and crystal-rich, strongly welded, eutaxitic subunit; 2) the upper subunit with an indurated or slightly welded, crystal-poor, pumice-rich vapour phase facies

The dominant mineralogy of Lower Sencca compound ignimbrites includes plagioclase (An13-68) + alkali feldspar (Or38-65) + biotite (XMg: Mg/Mg+Fe= 0.62-0.69) + clinopyroxene (Wo38-46En35-46Fs14-20) + orthopyroxene (Mg#: 0.68-0.78) + ilmenite (Ilm: 73-77%) + (titano)-magnetite (Usp: 16-36%) with accessory quartz, apatite and zircon. The mineralogical assemblage of Upper Sencca ignimbrite sheet consists of plagioclase (An6-44) + biotite (XMg: 0.66-0.69) + clinopyroxene (Wo40-43En42-43Fs13-19) + orthopyroxene (Mg#: 0.69-0.73) + ilmenite (Ilm: 40-76%) + (titano)magnetite (Usp: 8-28%) with accessory quartz, apatite and zircon.

Although Lower and Upper Sencca ignimbrites bear similar mineralogical assemblages, they exhibit different geochemical characteristics. Lower Sencca is relatively enriched in incompatible elements: Concentrations of Th (15-33 ppm), Nb (10-24 ppm), Ta (1-2 ppm), Y (12-30 ppm), Sm (4-11 ppm) and Rb (121-241 ppm) are higher than those of Upper Sencca, with Th (6-22 ppm), Nb (9-17 ppm), Ta (0.5-1.5 ppm), Y (4-24 ppm), Sm (1-8 ppm) and Rb (92-195 ppm). However, the ratios of incompatible elements between the two episodes of Sencca ignimbrite-forming eruptions are nearly constant (Ce/Yb ∼45-55, La/Yb ∼20-30). This indicates that both Sencca magmas have probably been originated from similar parental magmas. The more evolved composition of Lower Sencca contrasting with the less evolved nature of the Upper Sencca magma and Upper Barroso lavas indicate a probable replenishment of magmatic reservoir(s) following the emplacement of Lower Sencca ignimbrites. Initial Sr-isotope ratios and epsilon-Nd of the Upper Sencca ignimbrite are quite homogeneous ranging from 0.70593 to 0.70651 and from -3.76 to 3.06, respectively, whereas those of the Lower Sencca are more variable from 0.70502 to 0.70655 and +3.04 to -2.04. Nevertheless, Sencca magmatic isotopic signatures are less variable than that of the older ignimbrites.