Crustal magmatism as recorded in Ignimbrite Flare-ups

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Fueled by a transient elevated thermal flux from the mantle, an ignimbrite flare-up is a regional scale (>100 km^2) and long-lived (several to tens of millions of years) volcanic episode linked to profound crustal modification (Elston, 1984; de Silva, 1989; Best and Christiansen, 1991; Bryan et al., 2002; Lipman, 2007). Thus, such flare-ups account for a significant portion of what can be collectively termed crustal magmatism, mantle-powered but significantly crust-modified. The geologic imprint of these flare-ups are multi-cyclic caldera complexes that erupt hundreds to thousands of cubic kilometers of dacitic to rhyolitic ignimbrites in each eruption, along with abundant effusive volcanism. It is also being increasingly recognized that cordilleran batholiths are also constructed during these events (Ducea et al., 2001). Given the strong spatial, geochemical, petrological, and geophysical kinship between silicic volcanic and plutonic rocks it is reasonable to believe that volcanism must be accompanied by significant (and more voluminous) plutonic activity at depth. Co-genetic volcanic and plutonic rocks, with connections to deeper levels of the crust are to be expected. An integrated model for ignimbrite flare ups reveals that the high-level magmatism is the end result of feedbacks between lower crustal magma generation, advection of heat as magmas rise from depth, and the rheology of the crustal column. Such eruptions are rare and episodic suggesting that activity is modulated by crustal processes.

This is explored through the temporal record of the Altiplano-Puna Volcanic Complex of the Central Andes (de Silva et al., 2006), where the record of the flare-up reveals three types of signals. The broadest and dominant signal is that of the flare-up itself, a transient pulse magmatism of the order of 10^7 years that punctuates a background or baseline level of activity. This represents the waxing and waning of the heat engine, mantle power input. The second signal is system-wide episodicity that operates on a time scale roughly an order of magnitude faster. This is manifested by intense pulses of eruption that last from 10^5 to 10^6 years separated by periods of $2x10^6$ years. This is most likely the imprint of crustal processes, the crustal filter. The third signal is recorded in individual volcanic systems. Close correspondence between the timing of activity at separate long-lived caldera complexes, connotes a system-wide synchroneity in the development and eruption of these otherwise independent systems. This may reflect a tectonic imprint on the magmatic and volcanic record.