Short time scales and recent replenishment in large magmatic systems: case study of Los Humeros caldera complex

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Large magmatic systems associated with caldera complexes are usually considered to involve prolonged times required for the assemblage of eruptible melt. However, more recently, several reports reveal that some large volume systems are apparently assembled at much shorter timescales (e.g. Bishop, Santorini, Wakamaru, Yellowstone volcanic complexes). Here we present new geochronologic determinations by zircon U/Th and plagioclase $^{40}Ar/^{39}Ar$ dates that change substantially our understanding of the history of build-up and climax phases for Los Humeros volcanic complex (LHVC) respect to previous reconstructions. The new age for the emplacement of the voluminous Xaltipan ignimbrite (115 km^3 DRE) associated with the formation of the approximately 18 km-diameter Los Humeros caldera was determined at 164 ± 4.2 ka. The excellent correspondence between the majority of the zircon U/Th ages and the plagioclase Ar-Ar ages implies that the time between crystallization and eruption was not so long as expected for such large magmatic systems, instead the time for the assembly of the magma before the eruption of the Xaltipan ignimbrite was likely short, probably around 5 ka. The climax of volcanism at Los Humeros, represented by the Xaltipan ignimbrite was likely preceded by a peak in magma production rate consistent with the reconstruction of a much longer duration for the pre-caldera silica-rich volcanism ranging from 683 to 270 ky. We interpret that rapid build-up of eruptible magma can be explained by melt extraction from a parent crystal mush reservoir induced by injection of new magma, which is supported by the repeated occurrence in the LHVC stratigraphic record of recharge magma, in the form of basalts or hybrids (andesites); the most recent Holocene phase is dominated by heterogeneous bi-modal volcanism and eruption of basaltic and trachytic magmas from the outer ring-faults of the old LH caldera, revealing complex conditions at depth and could indicate replenishment of the resident reservoir. This rejuvenation of the system may be related to relatively high magma flux, indicating very fast magma storage and extraction rates from parent crystal mushes. These conditions have been interpreted also at large magmatic systems such as Yellowstone. We suggest that the current rejuvenation of the system could support the presence of high enthalpy geothermal resources (up to about 400 ºC) at shallow depths, substantially modifying models associated with pure heat conduction released from the LHVC magma chamber. Longevity and size of magmatic systems (very young and > *ca*. 1200 km^3 for the LHVC) are fundamental factors in the application of classical conductive models of heat resource, which can promote the heat production capacity and favoring a higher geothermal potential. At the same time we must also underline that an active recharge should also be taken in consideration for possible volcanic hazards.