# Zircon preservation in hybrid magmas from Mt. Hasan stratovolcano, Central Anatolia, and implications for magma mixing dynamics

**G. Gencoglu Korkmaz[1,2], K.A. Cionoiu[2], A.K. Schmitt[2,3]**

[1]*Konya Technical University, Department of Geological Engineering, Konya, Turkey*
[2] *Heidelberg University, Institute of Earth Sciences, Heidelberg, Germany*
[3]*Curtin University, John de Laeter Centre, Perth, Australia*
*e-mail: Gulin.Gencoglu@geow.uni-heidelberg.de*

Mt. Hasan, or Hasan Dağ, is a prominent stratovolcano within the Cappadocian Volcanic Province of central Anatolia. It experienced recurrent eruptions of mostly andesitic-dacitic lava flows from its main edifice on average every 5,000 to 15,000 years over the past 100 ka (Friedrichs et al. 2020). The northeastern flank of Mt. Hasan is dissected by a strand of the Tuz Gölü fault zone (TGFZ) with significant vertical and dextral offsets that in part have displaced lava coulees erupted from the eastern vent region of Mt. Hasan (little Mt. Hasan, or Küçük Hasan Dağ) from their respective source vents (Krystopowicz 2015). The volcano is underlain by a long-lived evolved magma reservoir that has remained viable for producing explosive and effusive eruptions since at least 550 ka (Friedrichs et al. 2020). Mafic magma recharge as evident by the presence of abundant rounded enclaves in Mt. Hasan lavas and geochemical mixing trends (Aydar & Gourgaud 1998) plays an important role in maintaining the magma system viable for such protracted durations. Here, we report mineral and whole-rock geochemical results for a suite of five lava flows from the eastern part of Mt. Hasan which were sampled on both sides of the TGFZ to provide piercing points for fault reconstruction. All lava flows yielded zircon, despite whole-rock compositions and mineral temperatures being clearly outside zircon saturation conditions. The implications of this observation on the timescales and processes of magma mixing are discussed here; geochronological analysis of zircon using U-Th and (U-Th)/He methods to determine crystallization and eruptions ages, respectively, is ongoing.

The investigated lavas compositionally span from basaltic andesite to dacite. They show hypocrystalline porphyritic textures with varying amounts of glass. Basaltic andesites primarily consist of plagioclase, olivine, pyroxene, Fe-Ti oxides, and additionally quartz, which based on embayments and ocellar textures is considered xenocrystic. In the andesites, plagioclase, pyroxene, and Fe-Ti oxide minerals are commonly present, along with amphibole (often with breakdown textures), and rare olivine. Dacites, on the other hand, contain plagioclase, amphibole, pyroxene, Fe-Ti oxides, and scarce quartz microphenocrysts. Apatite and zircon are present as accessory minerals in all lavas. Plagioclase pheno-microphenocrysts in almost all investigated rocks generally show inverse and oscillatory zoning with An-contents between 33 and 70 mol% and total FeO between 0.19 and 0.75 wt%. They typically display various types of sieve textures. Amphibole is ubiquitous in the lavas, and is mostly classified as Mg-rich hornblende. However, the degree of preservation in the basaltic andesite-andesite lavas is low as indicated by intense opacification and thick breakdown rims (4–8 µm). In the dacite lavas, amphibole represents the primary mafic phase and is mostly intact. Except in the most mafic lava flow, minor amounts of biotite are present in the groundmass, typically surrounded by breakdown reaction rims. Olivine with Fo = 89–86 mol% in basaltic andesite-andesite lavas is compositionally in disequilibrium with their host. In comparison, the andesitic lavas contain olivine with lower Fo contents ranging from 79 to 84 mol%. Diopsidic augite and enstatitic orthopyroxenes are commonly present, and they are variably zoned.

Mineralogical and petrographic features of Mt. Hasan lavas indicate a hybrid nature, where evolved magmas were reheated by mafic recharge. The evolved magma resided at comparatively low temperatures in an upper crustal magma reservoir (T = 800–835 °C, P = 110–150 MPa, based on amphibole geothermobarometry using the calibration of Ridolfi (2021), whereas eruption temperatures based on Fe-Ti-oxide pairs are up to 910°C. Taking new and published data for Mt. Hasan (e.g., Aydar & Gourgaud 1998) into account, kinked trends in major element oxides variation diagrams indicate a combination of magma mixing and fractional crystallization. Magma mixing between basaltic and dacitic endmembers can explain the hybrid basaltic andesites, whereby the basaltic endmember is more primitive than the erupted compositions of Mt. Hasan as indicated by the preservation of high-Fo (Fig. 1) and high-Ni olivine in the hybrid lavas. A compositional equivalent to the mafic endmembers in these mixing scenarios are basaltic scoria cones erupted in the vicinity of Mt. Hasan (Gencoglu Korkmaz et al. 2022; Reid et al. 2017). Zircon is preserved in even the most mafic hybrid lavas, where strong undersaturation and high Zr diffusivity in the melt would nominally dissolve zircon at rates of ~$10^{-11}$ m/s (900 °C), so that a zircon sphere 50 µm diameter would become completely resorbed by the melt within ca. 7 weeks. This implies that zircon was either shielded as inclusions in phenocrysts, or that mixing and hybridization occurred only briefly before eruption.

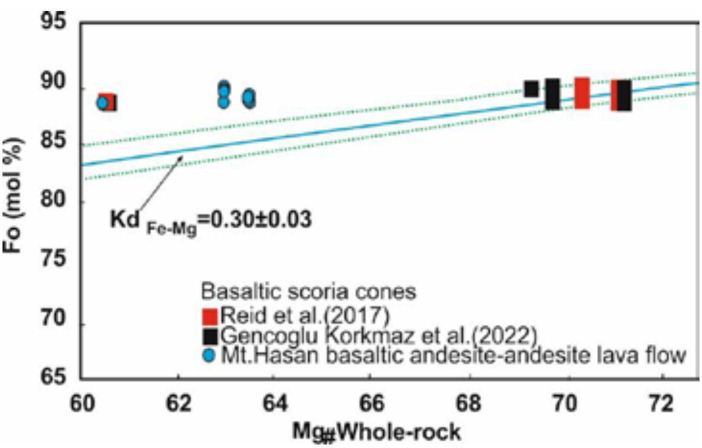


Figure 1. Whole-rock Mg≠ versus Fo (mol%) for olivine from northeastern Mt. Hasan basaltic andesite and andesite lava flows. Whole-rock and olivine compositions from scoria cones from the southwestern part of the Cappadocian Volcanic Province (Reid et al. 2017; Gencoglu Korkmaz et al. 2022) are shown for comparison.

Aydar E, Gourgaud A (1998): The Geology of Mount Hasan Stratovolcano, Central Anatolia, Turkey. - J Volcanol Geotherm Res 85, 129-152

Friedrichs B, Atıcı G, Danisik M.A, Çobankaya M, Harvey JC, Yurteri E. Schmitt AK (2020): Late Pleistocene eruptive recurrence in the post-collisional Mt. Hasan stratovolcanic complex (Central Anatolia) revealed by zircon double-dating. - J Volcanol Geotherm Res 404, 107007

Gencoglu Korkmaz G, Kurt H, Asan K, Petrelli M, Leybourne M (2022): The role of peridotite and pyroxenite melts in the origin of the Karapınar basalts, Cappadocia Volcanic Province, Central Anatolia. - J Geosci 67, 311-329

Krystopowicz NJ (2015):Constraining deformation, uplift, and activity along the Tuz Gölü fault zone, Central Anatolia, Turkey. - Master Thesis, Applied Science: University of Toronto

Reid MR, Schleiffarth WK, Cosca MA, Delph JR, Blichert-Toft J, Cooper KM (2017): Shallow melting of MORB-like mantle under hot continental lithosphere, Central Anatolia. - Geochem Geophys Geosyst 18, 1866-1888

Ridolfi F (2021): Amp-TB2: An updated model for calcic amphibole thermobarometry.- Minerals 11, 324