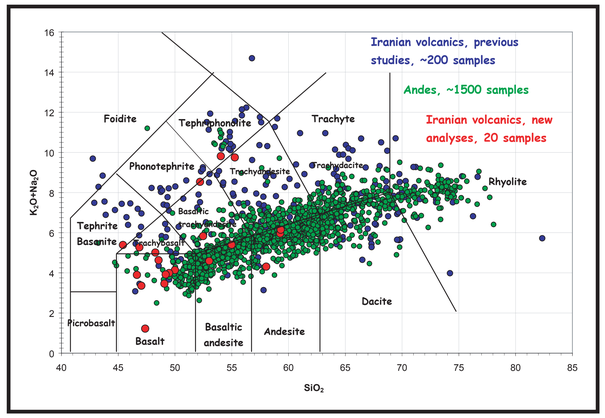
Tertiary volcanism and extension in central Iran

Charlie Verdel and Brian Wernicke

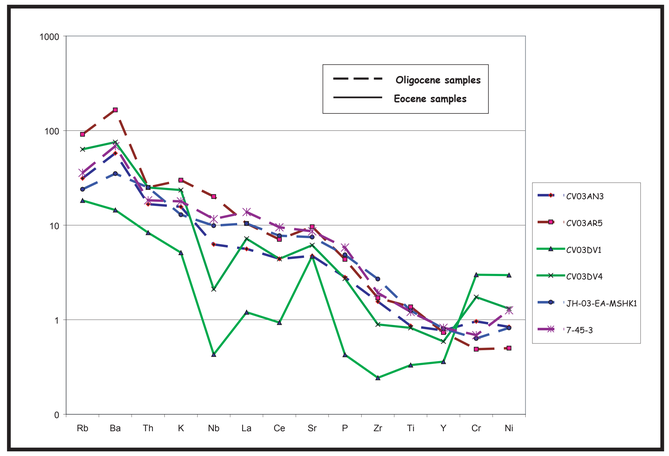
Abstract

The present topography of Iran has been created by the ongoing collision of Arabia and Eurasia. Most recent studies estimate that this collision initially occurred at approximately 10 to 20 Ma. Prior to the collision, some evidence suggests that central Iran may have been extending. The main evidence supporting this idea is the occurrence of Paleogene bimodal volcanism and the presence of marine carbonates of the Oligo-Miocene Qom Formation, suggesting the development of a marine basin across central Iran. Our study has focused on this phase of Iran's geologic history, and we have concentrated on the geochemistry of Tertiary volcanics and the newly recognized Saghand metamorphic core complex. Our work thus far suggests that Oligocene basalts are chemically ditinct from their Eocene predecessors and have trace-element compositions suggesting a back-arc basin affinity. Preliminary data suggest that the Saghand metamorphic core complex may have been active at approximately 15-20 Ma. Additional geochronology and thermochronology is necessary in order to verify these conclusions. Future work will concentrate on geochronolgy and thermochronology of samples collected over the last two summers and additional mapping of Saghand and a complete section of the Tertiary stratigraphy nearTafresh.

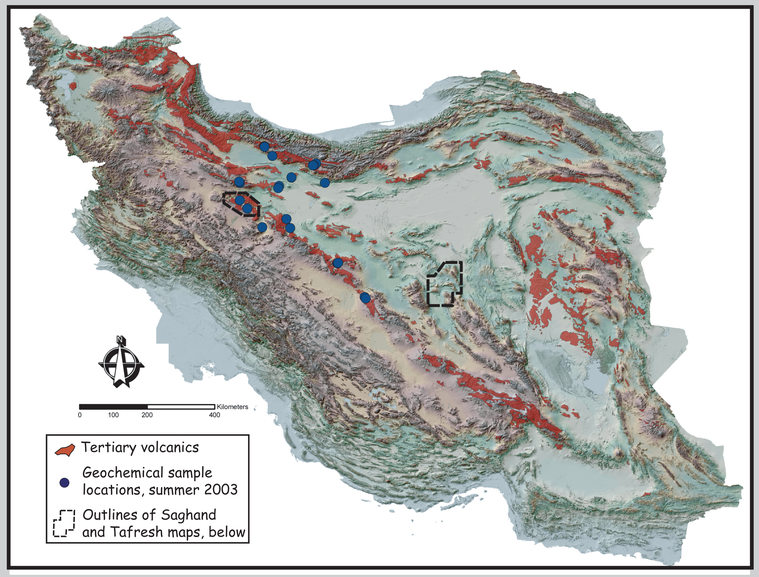
Geochemistry of Iranian volcanics



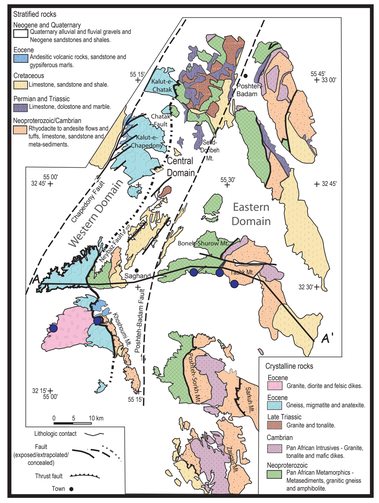
Blue dots on this total-alkali/silica digram represent a compilation of all available geochemistry data on Iranian volcanics prior to our study. A similar compilation of geochemical analyses from the Andes is shown for comparison. This initial data set suggested that Tertiary volcanism in Iran was significantly more alkalic than in other volcanic arcs. Red dots show XRF results from 20 mafic to intermediate samples that we collected. The three samples we collected with >8 wt% Na2O + K2O contain the zeolite analcime, suggesting that much of the unusually alkalic nature of the Iranian volcanics may be secondary.

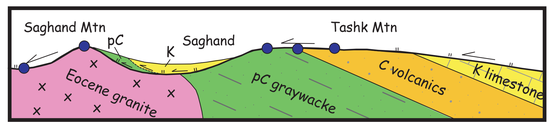


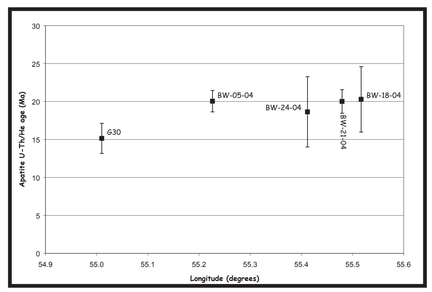
MORB-normalized spider diagram of our samples with <53% SiO2 and >6% MgO. "Spiky" patterns are typical of volcanic arcs, where volcanics are derived from two components: a subducting slab and the overlying mantle wedge. Relatively flat patterns are more commonly seen in back-arc basins or OIB settings where only one component is involved in magma production. This limited number of samples suggests that Eocne volcanism was dominantly of typical flux-melting type, while Oligocene volcanism may have been related to extension.



Saghand: a central Iranian metamorphic core complex







During the summer of 2004, we did reconnaissance mapping of the Saghand area in central-eastern Iran. The area is characterized by a detachment fault (previously mapped as a thrust) that places unmetamorphosed Cretaceous limestones over mylonitic footwall rocks of Eocene to Precambrian age. Mylonitic lineations, combined with an analysis of microstructures, indicate a general top to the west or northwest sense of movement. We collected a horizontal transect of U-Th/He samples in the footwall of the detachment and augmented our transect with samples previously collected by our collaborator, Jahan Ramezani. For those samples which have produced reliable results, U-Th/He apatite ages are uniformly ~15-20 Ma.

Future work

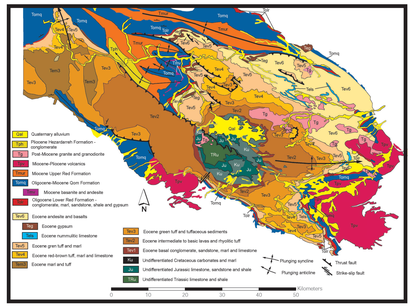
-Geochronology of volcanic samples

We currently have approximately 15 samples awaiting Ar/Ar analysis at the Berkeley Geochronology Center. The stratigraphic positions of these samples comprise a composite section through the predominantly Eocene volcanic arc. Radiometric dates of Iranian volcanics are decidedly sparse, and these dates will both augment our geochemistry study and allow us to make estimates of changes in eruption rate over time.

-Thermochronology of Saghand samples

In addition to the apatite U-Th/He results that we have obtained, we also have zircon and titanite separates that will allow us to perform higher temperature thermochronology. We anticipate that the combined results of U-Th/He analysis will indicate the timing of exhumation of the footwall in the Saghand metamorphic core complex.

-Additional mapping in Tafresh



The area around the small town of Tafresh, approximately 200 km southwest of Tehran, appears to contain the most complete section of Tertiary startigraphy in Iran. The full thickness of the Eocene volcanic succession is preserved in this area. Mapping, geochronology and thermochronology in this area will help unravel the history of the volcanic arc, provide information about the onset of deformation in central Iran, as well as illustrating neotectonic features of the area.

Looking north from Tafresh at volcanic flows, pyroclastics and vertical feeder dikes.