Carbon in the mantle lithosphere

Meghan R. Guild

Carbon is one of the most important elements on Earth, as it is the basis of all life, it fuels human civilization, and modulates climate. On Earth's surface, carbon is exchanged between the atmosphere, terrestrial biosphere, oceans, and sediments. The timescales and amount of carbon exchanged on Earth's surface are well characterized. However, the carbon on Earth's surface makes up only ~1% of Earth's total carbon budget. The vast majority of Earth's carbon (~99%) is found in its interior (mantle and core), making it much more challenging to investigate. To better understand the long-term contribution of Earth's interior carbon to climate and life through geologic time, our understanding of Earth's deep carbon must be improved.

In this study, this significant gap in knowledge will be addressed by determining the amount of carbon stored in rocks from Earth's interior, sampled by volcanoes, namely xenoliths. Through the analysis of carbonates and fluid inclusions hosted in those xenoliths, the abundance, sources, and forms of carbon stored in the mantle lithosphere using carbon and oxygen isotopes, determining the entrapment temperature and composition of fluid inclusions, and investigating aqueous carbon speciation at entrapment temperatures by theoretical thermodynamic modeling of fluid inclusion chemistry at lithospheric mantle conditions. This study will provide much needed constraints on the amount and sources of carbon in the mantle, specifically targeting samples from the southwestern United States. ■

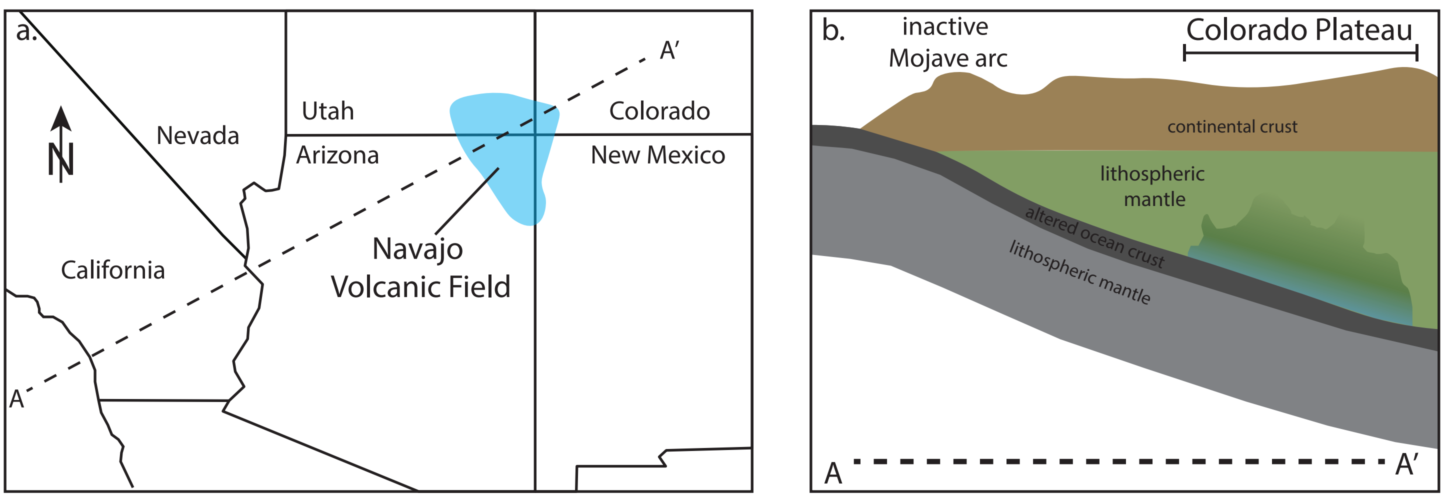

Figure 1. Geologic setting for the proposed study. (a) Map view of the southwestern U.S. with state-lines. Blue field represents the extent of the Navajo Volcanic Field. Dotted line A-A' shows the location of the cross section represented in b. (b) Cross section of Farallon flat-slab subduction zone during Eocene based on Humphreys et al. (2003). Gradient represents dehydration of serpentine and percolation of fluids upwards to hydrate and metasomatize the Colorado Plateau. After Marshall et al. (2017).

References

Humphreys, E., E.Hessler, K. Dueker, G.L. Farmer, E. Erslev, T. Atwater (2003). How Laramide-age hydration of North American lithosphere by the Farallon Slab controlled subsequent activity in the western United States, Int Geol Rev, 45, 575-595, doi.org/10.2747/0020-6814.45.7.575

Marshall, E.D., J.D. Barnes, J.C. Lassiter (2017). The role of serpentinite-derived fluids in metasomatism of the Colorado Plateau (USA) lithospheric mantle. Geology, 45, 12, 1103-1106, doi.org/10.1130/G39444.1