Origin of Late Cretaceous, continental interior, volcanism in the Rocky Mountain region

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Background

During the Late Cretaceous parts of the western U.S. were intruded by small-volume continental volcanism (~1500 km² inward from the Pacific margin. These intrusions include the Colorado Mineral Belt (COMB) and Sliderrock Mountain, Montana. The continental lithosphere in these areas is quite thick, and the mechanisms by which these volcanic rocks were generated and erupted through this lithosphere are not well understood.

We compared the chemistries of several volcanic centers to better understand the roll of the lithosphere in magma generation. Slide Rock Mountain erupted through Archean (~2.6 Ga) lithosphere, whereas, the Windy Gap Member erupted through Proterozoic (~1.7 Ga) lithosphere. If pre-existing continental lithosphere was involved in magma generation, the difference in age and composition of the lithosphere in these regions should be apparent in the chemistries of these volcanic rocks because it was imparted from their parental magmas.

Thermal Ionization Mass Spectrometry

In order for our Sliderrock Mountain volcanic rocks to reach the state that can be analyzed by the spectrometer, they must first be chemically purified by performing standard column separation methods.

TIMS - Geochemical Results

We analyzed mafic basalt samples that show negative ε Nd values and likely came out the continental mantle lithosphere (chronodite reservoirs). Modern asthenospheric values of ε Nd are positive, the ε Nd values of these basalt samples are too low for them to have been derived from melting of the asthenosphere. If you have lower a 147Sm/143Nd ratio it will plot as a negative ε Nd value, as time goes by, because partial melts of the mantle are rich in IREE.

In regard to the origin of the magmas, since the decay of 147Sm/143Nd is always happening the isotopic compositions of the Windy Gap Member plot less negatively in comparison to those of Sliderrock Mountain. The longer the magma has been separated from its source means it will develop increasingly negative ε Nd values.

Conclusion

The extrusive igneous activity in both volcanic suites have similar bulk compositions.

The magmas could not have originated in the asthenosphere or else they would be expected to have high positive ε Nd values.

These magmas are too mafic to have been generated by crustal melting. Therefore, the negative ε Nd values in these mafic magmas suggest the magma at both locations were derived from light rare element enriched continental mantle lithosphere, and that the ε Nd differences reflect differences in mantle lithosphere age.

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References


