ORIGIN AND EVOLUTION OF LATE MIOCENE-PLEISTOCENE BASALT: CENTRAL MOUNT BENNETT HILLS, CENTRAL SNAKE RIVER PLAIN, IDAHO

CLASON, Hayden D[1], BADON, Esther C[1], JONES, Keeanah M[1], VETTER, Scott[1] and SHERVAIS, John[3], (1) Geology, Centenary College of Louisiana, 2911 Centenary Blvd., Shreveport, (3) Geology Department, Utah State University, Logan, UT

Abstract

The Snake River Plain of southern Idaho represents the track of a hot-spot. The Mount Bennett Hills lie north of the Snake River-Yellowstone track, near the intersection of the eastern and western SRP. The Central Mount Bennett Hills exhibits the most abrupt uplifting of the entire range. The range gradually rises out of the SRP to the range's crest and then drops abruptly to the Camas Prairie. Voluminous mid Miocene (8-13 Ma) rhyolitic ash-flows and lava flows are exposed along the Mount Bennett Hills. These rhyolites unconformably rest on Cretaceous granitic rocks of Idaho batholith and are overlain by minor Tertiary basalt flows and sediments. We have sampled eleven Late Miocene to Pleistocene basaltic lava flows from six quadrangles. Based on the Idaho Geological Survey mapping the flows seem to be mono-eruptive flows from separate small vents.

Hand samples range from black to gray with the darkest samples being aphyric and the lightest samples being plagioclase phyric. The medium gray colored samples tend to be olivine plagioclase phyric. The size of olivines are approximately 0.5-1.5 mm in size, while the plagioclases ranged from approximately 0.5 to 5 mm in size. Approximately one third of the samples were slightly to moderately vesicular. Forty-three samples were selected for our study of basaltic volcanism in the central Mount Bennett Hills. These samples were studied petrographically and by SEM. Mineral endmembers were determined by SEM-EDS. The basalts consist of plagioclase and olivine phenocrysts set in a groundmass of olivine, plagioclase, clinopyroxene, and oxides. Olivine phenocrysts endmember ranged from Fo88-60. Plagioclase phenocryst endmembers ranged from An69-56. Groundmass pyroxene endmembers ranged from Wo45-35 En59-47 Fs18-8. Cr spinel, ilmenite, and Ti magnetite were present in many of the samples. One flow unit (Square Mt.) represents a hybrid flow with much more evolved mineral data.

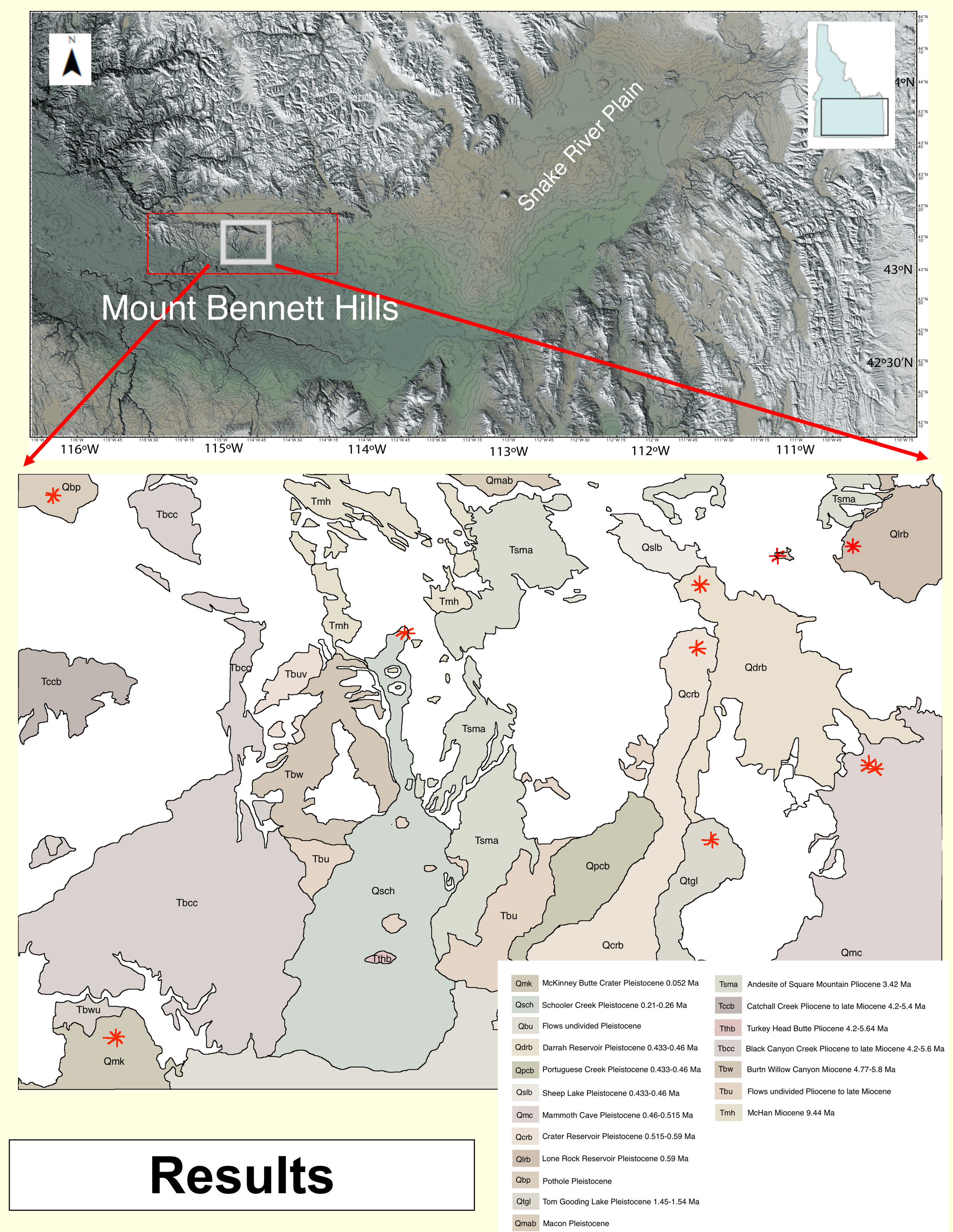
The samples were analyzed for major and trace elements. The majority of samples have Mg# ranging from 65-39. One flow (Square Mt) are more evolved as indicated by Mg# ranging from 35 to 25. The high Mg# samples have the following chemical ranges: TiO2 1.2 – 3.8 wt.%; FeO 7.3 – 16.1 wt.%; Nb 5-41 ppm; Zr 60-566 ppm; Ni 10-250 ppm; La 8.7-81 ppm. All magmas exhibit LREE enrichment. LaN/LuN ratios range from 3 to 7. Our hybrid flow has a LaN/LuN ratio of 4 to 10.

Initial trace element modeling suggests 30 to 76% of olivine fractionation of our selected parent sample would result in rare earth concentrations similar to our most evolved rocks in our suite.

Geologic Setting

The Mount Bennett Hills (MBH) is an E-W trending (approximately 100x20 km) horst situated along the northern margin of the west-central Snake River Plain (SRP). Much of the MBH comprises of voluminous mid-Miocene rhyolitic ash-flows and lava flows (Idavada volcanics) with minor interbedded sediments and capping basalt. The Idavada volcanics generally dip and thicken toward the SRP where the rhyolites are overlain by Late Miocene to Quaternary basalt flows and sediments. The MBH are cut by numerous normal faults trending northwest, northeast, and west. The northwest-trending faults are the dominant structures. Our study area consists of nineteen basaltic flows ranging in age from Mid-late Miocene to Pleistocene. Average basaltic flow areas range from 1 to 182 km2. Many of the flow units lack an observed associated vent.

Figure 1
Location of Mount Bennett Hills at the northern boundary of the East Snake River Plain and the Western Snake River Plain.



Results

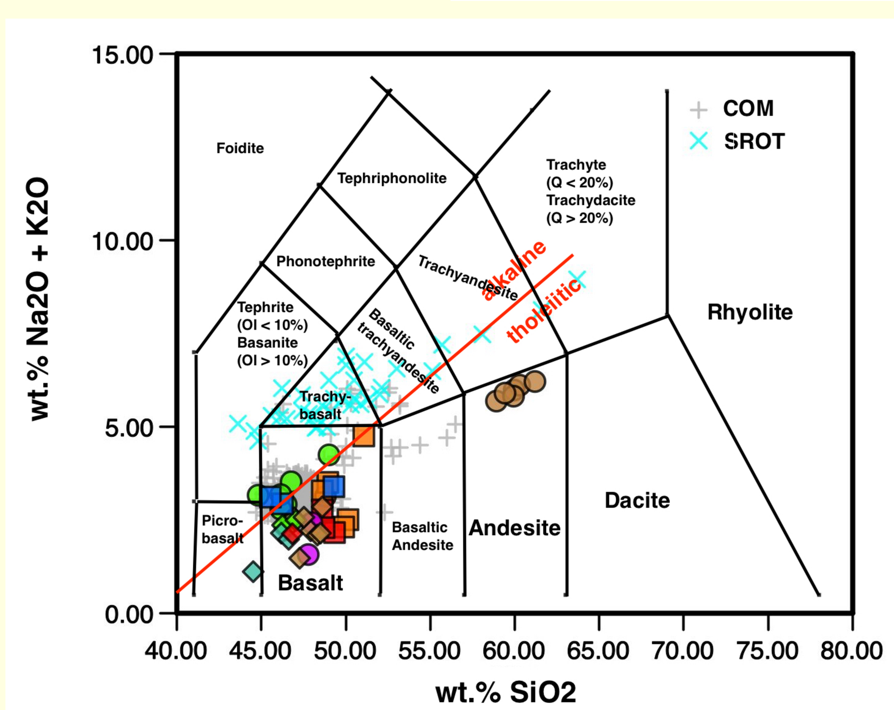


Figure 2: TAS Plot
All flows except Square Mountain are basalts based on the TAS plot. Square Mountain is andesitic based on TAS. The basaltic flows are similar to SROT of the ESRP. Square Mountain although more evolved are lower $Na_2O + K_2O$ than the COM lavas. Whole rock major elements were determined on glass beads made in an O_2 free strip furnace and analyzed using EMP techniques at Rice University. A USGS standard (BHVO-2) was used as an internal standard.

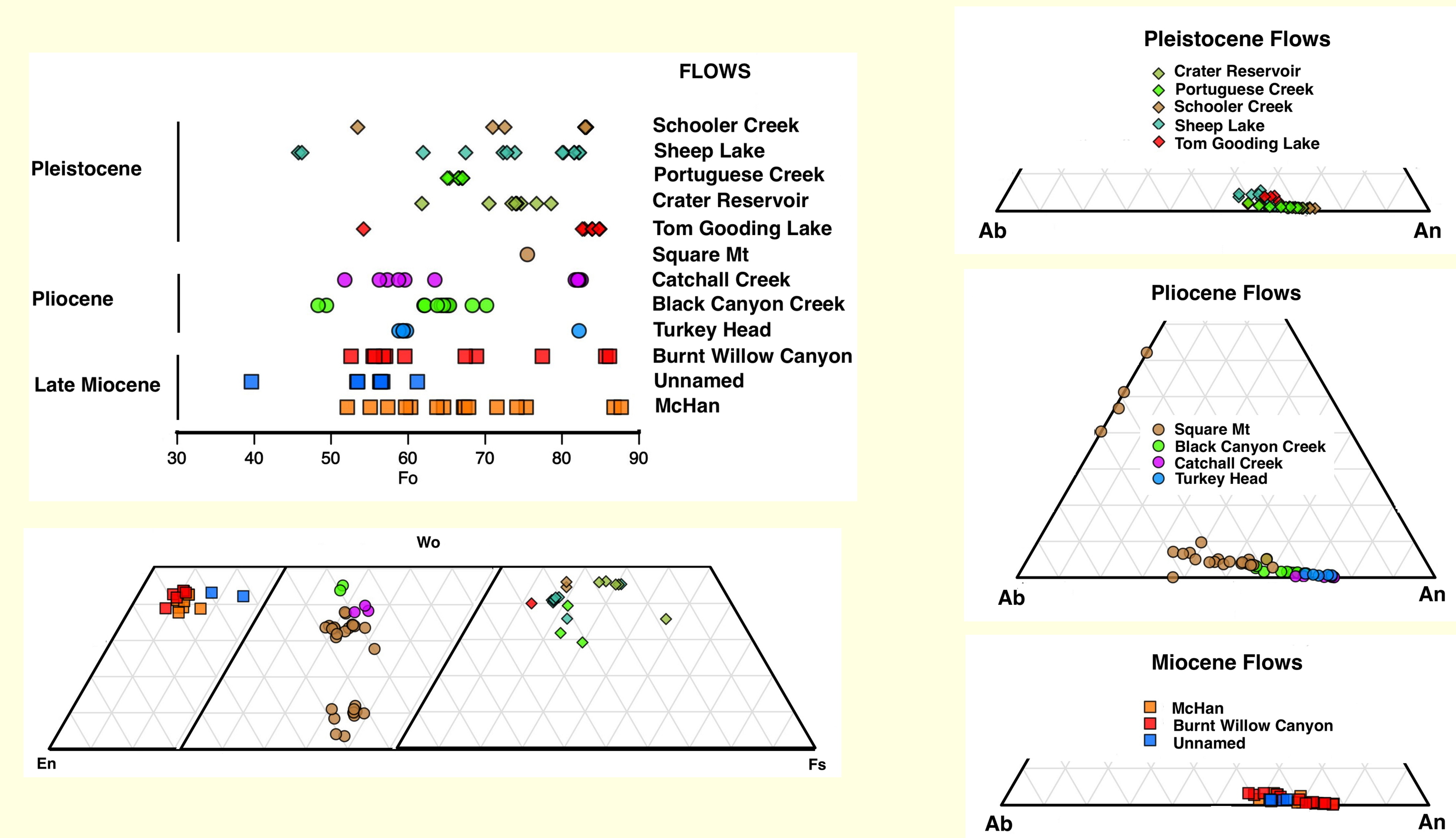


Figure 3: Phases
All of the flows with the exception of Square Mt flow are olivine and plagioclase phyric. Most of the flows contain olivine and plagioclase phenocrysts set in a groundmass of plagioclase, clinopyroxene, and oxides. Cr spinel was found in numerous olivine phenocrysts in a number of the flows. Square Mt. flow consists of plagioclase and pyroxene phenocrysts in a very fine grained/glassy groundmass of plagioclase and pyroxene. Olivines range from Fo_{88-33}. There is no time related range in olivines. Plagioclases range from An_{78-34} with little to no Or component. Within Square Mt. flow groundmass K-spar was observed. Like the olivines there is no time correlation with the plagioclases. All pyroxenes are augites and do show an Fe enrichment within the younger flows. Square Mt. has pigeonite phenocrysts along with clinopyroxenes. All the pyroxenes (except Square Mt.) were groundmass.

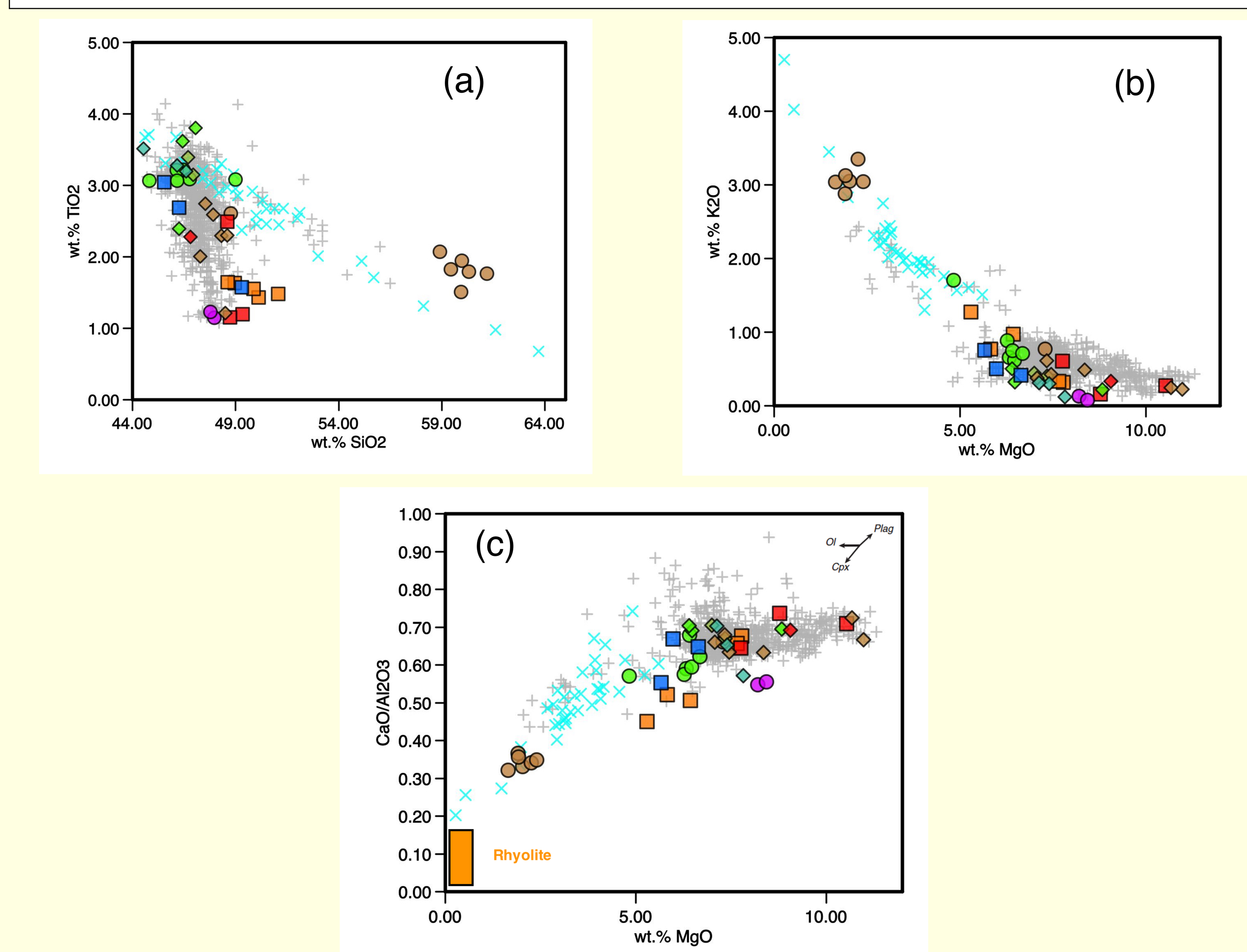


Figure 4: Major Elements
(a) Majority of the flows fall within the SROT tend. Square Mt. flow however tends along with COM. There seems to be a possible age relationship with TiO2, the older flows lower TiO2, younger flows higher TiO2. (b) Majority of the flows fall within the SROT tend and range from "parental" to more evolved basalts. Again Square Mt. are similar to COM. (c) Flows indicate olivine fractionation dominates however a number of samples suggest cpx fractionation (Jean et al, 2018).

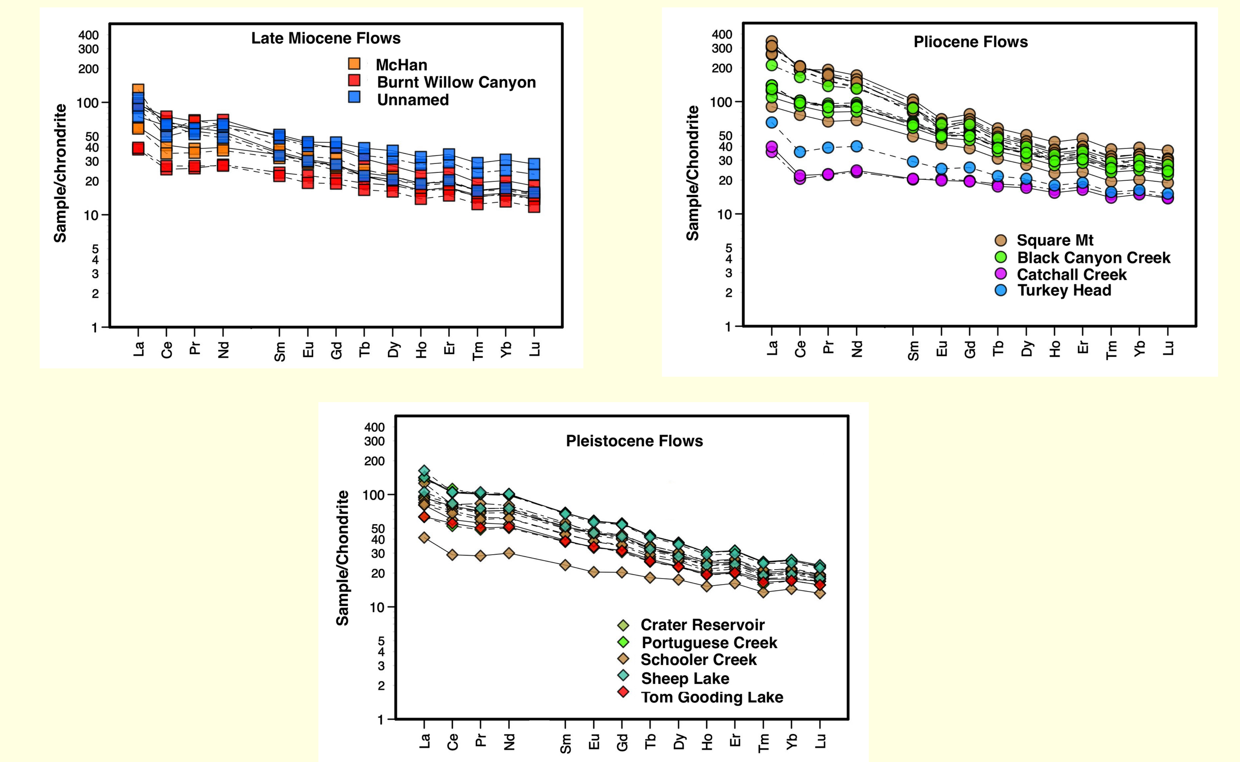


Figure 5: REEs
Rare Earth Element patterns for the flows are LREE enriched with La_n ranging from 40 to 350. There is no time relationship with the REEs.

Discussion

Using our most "parental" samples (high MgO > 10 wt.%) we tested olivine fractionation to match observed REE patterns of the evolved samples. Based on this modelling our "parental" samples can not fractionate olivines to get the all of the observed REE patterns.

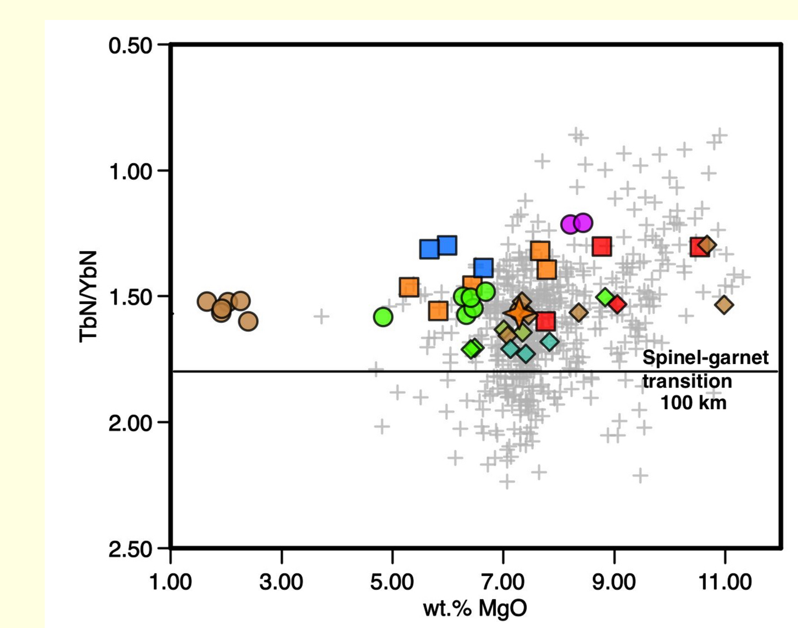


Figure 6: (Tb/Yb)n vs MgO
MREE/HREE ratio can be used as an indicator of the presents of garnet vs spinel within the mantle source region. Jean et al (2018) suggested a (Tb/Yb)n > 1.8 suggests a garnet peridotite source region. Ratios less than 1.8 suggests a spinel peridotite source region. Our samples all have (Tb/Yb)n < 1.8 indicating a spinel peridotite source.

Literature cited

Marlon M Jean, Eric H Christiansen, Duane E Champion, Scott K Vetter, William M Phillips, Stephan Schuth, John W Shervais; Caldera Life-Cycles of the Yellowstone Hotspot Track: Death and Rebirth of the Heise Caldera, Journal of Petrology, Volume 59, Issue 8, 1 August 2018, Pages 1643–1670.

McDonough, W. F. & Sun, S-S. (1995). The composition of the Earth. Chemical Geology 120, 223–253.

Centenary COLLEGE OF LOUISIANA

STATE

2020 Geological Society of America South-Central Section Meeting
Ft. Worth, TX 9-10 March