Petrography and geochemistry of mafic-intermediate dikes from the northern Sawatch Range, Colorado

Albert M. Barbery barberya21@mycu.concord.edu
Stephen C. Kuehn sckuehn@concord.edu
Joseph L. Allen allenj@concord.edu
Department of Physical Sciences, Concord University, Athens, WV, 24712

Poster No. 246
GSA Annual Meeting: Denver, CO
Session 247: T165. Sigma Gamma Epsilon Undergraduate Research (posters).
2-6:30 PM Tuesday 29 October 2013

1. Abstract

The Homestake shear zone (HSZ) is a subvertical, NE-striking structure that originated during Paleoproterozoic continental assembly and was reactivated under lower temperatures during Mesoproterozoic intracratonic transpression. Original geologic mapping (Tweto, 1974) differentiated numerous lithologically distinct dikes that are spatially associated with the shear zone. On the basis of field relations and lithology the dikes can be differentiated into several sets; we focused on metalamprophyres and hornblende diorites hosted within biotite gneiss and migmatite. The hornblende diorites are locally folded and include folded leucosomes that suggest they participated in an early phase of high-temperature melting. This high-temperature melting is consistent with an early 1.7 Ga deformation event in the HSZ. The metalamprophyre dikes crosscut the 1.7 Ga fabric in the host gneiss and show a distinct foliation sub-parallel to the dike walls. In order to better understand the geochemistry and petrography of the dikes, we analyzed 8 metalamprophyres and 4 hornblende diorites using EPMA, and used whole-rock XRF to determine major and trace elements. We also analyzed an additional suite of 27 REE's and trace elements for each lithology using ICP-MS. The metalamprophyres average of 54.27% SiO_2, 12.58% Al_2O_3, 8.97% FeO, 8.63% MgO, 1.49% Na_2O, and 0.64% P_2O_5. In contrast, the hornblende diorites average 52.37% SiO_2, 16.3% Al_2O_3, 11.01% FeO, 6.94% MgO, 0.60% Na_2O, and 1.01% P_2O_5. The metalamprohpyres thus have greater abundances of MgO and Na_2O while the hornblende diorites have greater abundances of Al_2O_3, FeO, and P_2O_5. Some trace elements showed significant differences; metalamprophyres average of 241 ppm Ni, 580 ppm Cr, and 377 ppm Zr whereas the hornblende diorites average 128 ppm Ni, 177 ppm Cr, and 662 ppm Zr. These results show that the dikes have both distinctly different field relations and geochemistry; we suggest the hornblende diorites may be Paleoproterozoic and the metalamprophyres are younger and possibly related to a widespread Mesoproterozoic tectonothermal event that broadly coincides with reactivation of the HSZ.

2. Geologic Map of the northern Sawatch Range

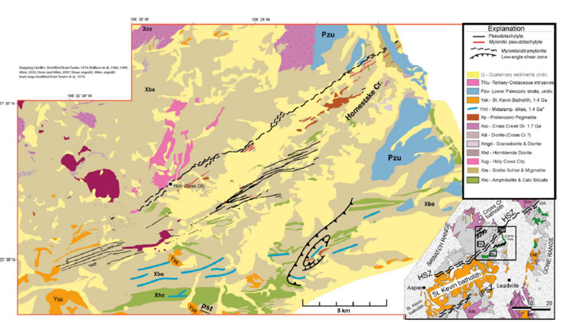


Figure 1 shows a geologic map of the Homestake shear zone field area where samples of the metalamprophyre (blue lines) were collected.

3. Methodology

Sample Preparation

The samples were cut into thin section sized rectangles using the geology department's thin section prep equipment. Those pieces were then sent to Spectrum Petrographic to be made into polished thin sections. Whole rock samples were sent to Washington State University for whole rock geochemistry analysis of each sample.

Analytical Methods

- Whole Rock Geochemical Analyses- X-ray Fluorescence (**XRF**) and Inductively Coupled Plasma Mass Spectrometry (**ICP-MS**) Analyses
- Electron Microprobe- Energy Dispersive Spectrometry (**EDS**)
- Petrographic Microscope Observation & Modal Point-count analysis

The Whole Rock Analyses (XRF, ICP-MS) were done at Washington State University. The EDS Analyses were preformed using the electron microprobe at Concord University.

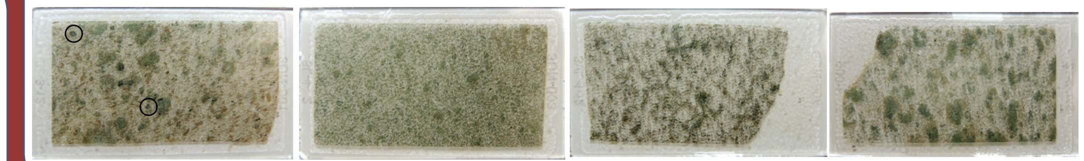
4.

Modal Analysis (based on 300 points per thin section)

Mineral	SL-4-12	SVL-4-12	SVL-8-12	BL-3-12
	vol. %	vol. %	vol. %	vol. %
Hornblende *	65.33	31.33	36	39.67
Biotite	18.67	19	25.67	35
Plagioclase	7.67	31.33	23.33	11.67
Quartz	7.67	16	15	11.33
Opaques	0.33	2.33	0	2
Zircon	0.33	0	0	0.33

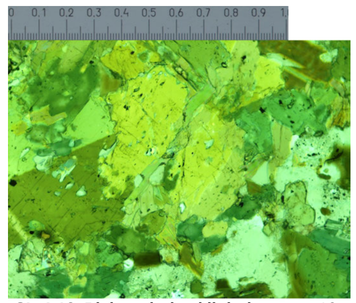
* Also includes any actinolite and pumpellyite

5. Thin sections examined

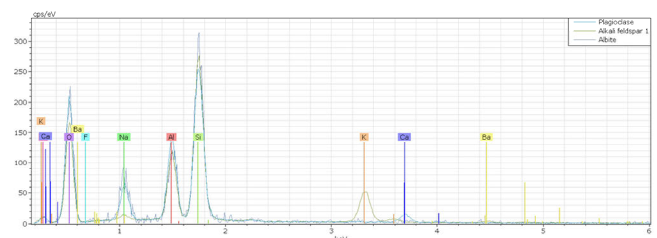


BL-3-12 (photomicrographs circled) SL-4-12 SVL-4-12 SVL-8-12

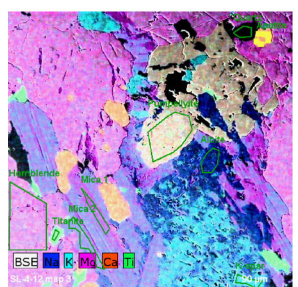
6. Rock SL-4-12 (Slide Lake)



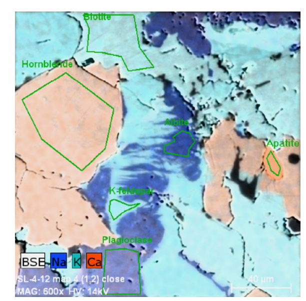
SL-4-12. Plain polarized light image at 10x magnification. This shows the bulk mineralogy of the host material in the dikes.



SL-4-12 Spectra: Showing the difference between the Albite and Alkali Feldspars in the Perthite. Ba content was a surprising 3-4 wt%, Ba as Barium oxide. This sample is also contains Amphibole, Mica, Quartz, Titanite, and Apatite.

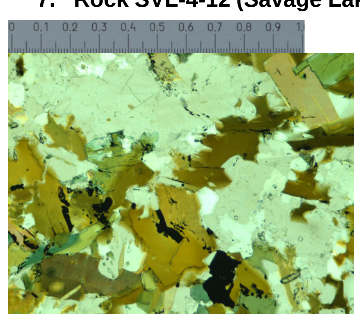


SL-4-12 EDS Map showing several of the main minerals in the rock, including quartz, feldspars, micas, hornblende, apatite, and titanite. Note the compositional variations within the micas and feldspars.

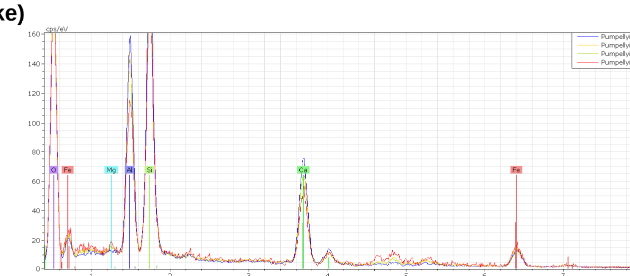


SL-4-12 EDS Map showing perthitic alkali feldspar, plagioclase (~An_{20}), hornblende, biotite, and apatite.

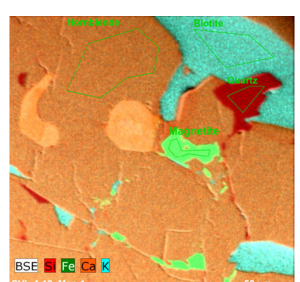
7. Rock SVL-4-12 (Savage Lake)



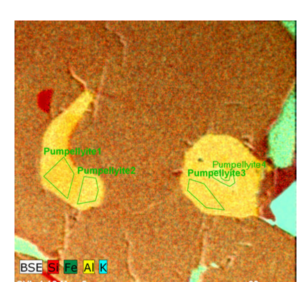
SVL-4-12. Plain polarized light image at 10x magnification.



SVL-4-12 Spectra showing the variances in Ca, Fe, and Mg concentrations in the pumpellyite.

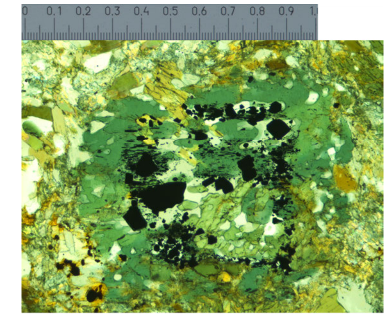


SVL-4-12 EDS Map showing hornblende, biotite, quartz, magnetite, and pumpellyite (not labeled).

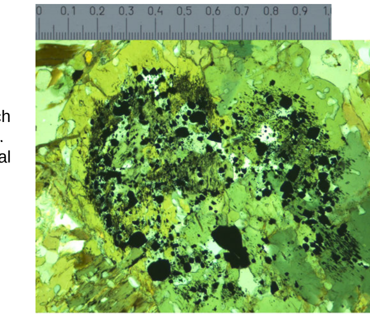


SVL-4-12 EDS Map showing the regions for the EDS spectra shown above.

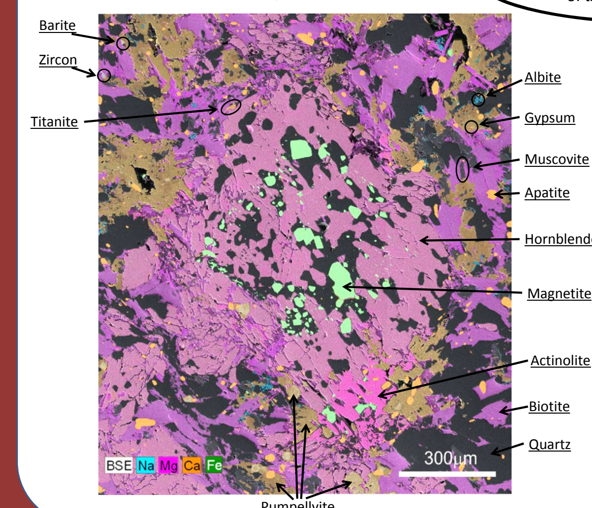
8. Rock BL-3-12 (Brady Lake)

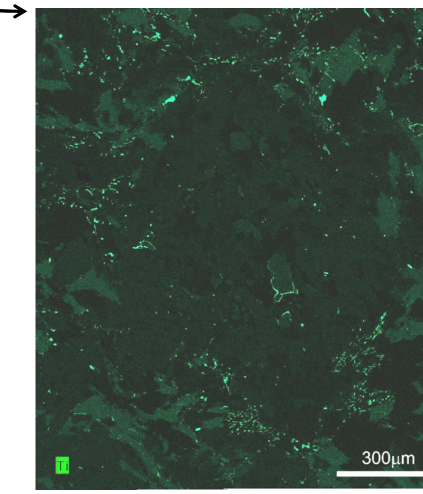


BL-3-12. Plain polarized light images at 10x magnification. These show replacement textures. Note the magnetite-rich cores and hornblende-rich rims. This suggests an Fe-rich mineral in the core with an overgrowth that have been subsequently replaced.



BL-3-12 EDS Maps the major and accessory phases (left) and the location of titanite and trace barite (right). Note the association of titanite with pumpellyite and as rims on magnetite.

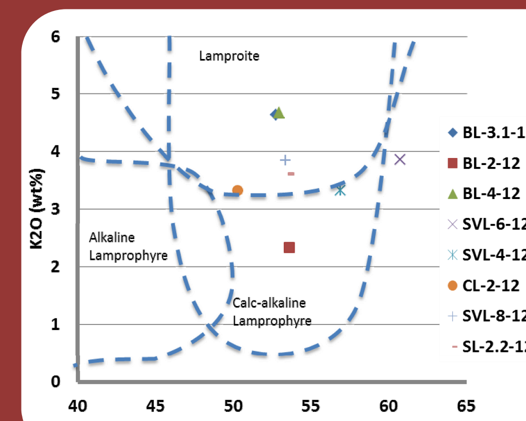




9.

Whole-rock Geochemical Results

	BL-3.1-12	BL-2-12	BL-4-12	SVL-6-12	SVL-4-12	CL-2-12	SVL-8-12	SL-2.2-12
SiO_2	52.74	53.61	52.94	60.75	56.88	50.28	53.36	53.58
TiO_2	0.96	1.33	1.15	1.19	1.24	0.47	1.00	0.84
Al_2O_3	13.29	14.58	13.75	14.05	15.26	15.97	13.28	14.21
FeO	9.33	10.37	8.91	6.93	8.10	10.17	8.94	8.97
MnO	0.15	0.17	0.14	0.12	0.14	0.17	0.18	0.17
MgO	10.48	8.52	8.19	5.46	6.31	10.38	9.43	10.28
CaO	7.02	7.27	7.24	5.21	6.59	7.43	7.69	6.20
Na_2O	0.57	1.47	2.18	1.70	1.46	1.76	1.41	1.38
K_2O	4.64	2.33	4.67	3.85	3.32	3.32	3.84	3.61
P_2O_5	0.82	0.36	0.85	0.74	0.71	0.06	0.88	0.75
$Na_2O + K_2O$	5.20	3.80	6.84	5.55	4.78	5.07	5.25	4.99



10. Geochemical Classification

SiO2 vs K2O plots for lamprophyre classification (Rock,1987).

Using the XRF Whole rock geochemical data five of the mafic-intermediate dikes plotted as Lamproites while 2 plotted as Calc-alkaline Lamprophyres.

Acknowledgements

This research was made possible with funding from the WV/Strasko Research Trust Fund Grant through the Faculty-Student Research Program at Concord University. A WV HEPC Innovation Grant funded the EDS which was used in this research project.

CONCORD UNIVERSITY

11. References

Rock, N.M.S., 1987. The nature and origin of lamprophyres: an overview. In: Fitton, J.G., Upton, B.G.J. (Eds.), Alkaline Igneous Rocks. Geol. Soc. Spec. Pub., vol. 30. Blackwell, London, pp. 191–226.

Tweto, O., 1974. Geologic map and sections of the Holy Cross [15 minute] quadrangle, Eagle, Lake, Pitkin, and Summit Counties, Colorado: U.S. Geological Survey Miscellaneous Investigations Series Map I-830, scale 1:24,000.

Deer, W., Howie, R., and Zussman, J., 2013. An Introduction to the Rock-Forming Minerals, 3rd ed.. The Mineralogical Society. London.