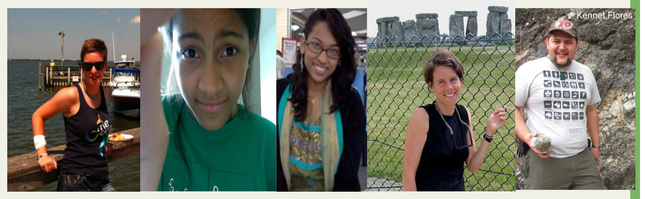
Comparing the Mineralogy and Petrography of Eclogites and Garnet Amphibolites from the North Motagua Mélange (Guatemala Suture Zone).

By: Erin McKinney[1], Mariah Apollon[2], Samina Aktar[3], Dr. Rondi Davies[4], Dr. Kennet Flores[4]

1. The High School For Math, Science and Engineering @ CCNY, 2. High School for Environmental Studies, 3.High School for Health Professions and Human Services, and 4. The American Museum of Natural History

AMERICAN MUSEUM OF NATURAL HISTORY



Abstract

The Guatemalan suture zone is the area where the North American and Caribbean plates converge at a transform boundary, the history of which is recorded by the presence of high-pressure, low temperature (HPLT) eclogites and high-pressure, high temperature amphiboles found on both sides of the fault zone. Our research involved a close examination of samples from an area of interest on the northern side of the mélange that, through previous research, has been dated to about 130 million years old, much closer to the age of the older southern rocks. We used a wide variety of methods, including X-ray diffraction, thin section analysis and isotope dating to analyze these minerals and study their age and tectonic history in close detail.

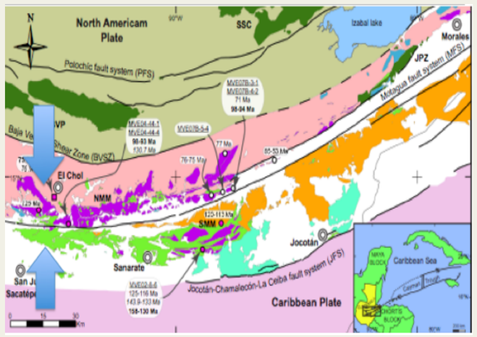


Figure 1. Guatemala Suture Zone with the North American and Caribbean plates transform boundary, where samples were collected.

Figure 2. Photo 1: A grain ready for XRD analysis on a fiberglass pin, Photo 2: Samina picking minerals, Photo 3: A fully separated sample, Photo 4: Samples after magnetic separation

Materials and Methods

For the purposes of our study, a variety of methods were exercised:

- Mineral separation and disaggregation were conducted through the processes of selfrag, magnetic separation, and hand separation under binocular microscope (Figure 2).
- In determining the specific mineral types present mineral identification was conducted on single grains using a Rigaku X-ray diffractometer.
- Analyzing the thin section and mineral petrography relationships were done using a petrographic microscope.
- Electron Microprobe Analysis determined mineral compositions using a 5-spectrometer Cameca SX-100 electron microprobe.
- Modal abundances and whole rock compositions were calculated from maps of thin and ImageJ sofware.

Results

Table 1: Mineral separation of two eclogites and one amphibolite yielded the following samples for isotope dating.

Sample No.	Sample	Magnetic Fraction (amp)	Weight (g)
Mariah			
MVE07B-19-11	NMM-1 Grt 1 (0.4)	0.4	2.18
MVE07B-19-11	NMM-1 Grt 1 dropped	0.4	0.94
MVE07B-19-11	NMM-1 Grt 1 (0.5)	0.5	1.54
MVE07B-19-11	NMM-1 Omp	1.2	0.48
MVE07B-19-11	NMM-1 Mus	non mag	0.22
Erin			
MVE07B-12-1	NMM-2 Grt 2 (0.5)	0.5	2.72
MVE07B-12-1	NMM-2 Grt 2 small (0.5)	0.5	0.47
MVE07B-12-1	NMM-2 Amp (0.5)	0.6	1.22
MVE07B-12-1	NMM-2 Mus (0.5)	1.2	0.24
Samina			
MVE10-58-2	NMM-3 Grt 1 (0.4)	0.4	1.17
MVE10-58-2	NMM-3 Grt 2 (0.4)	0.4	1.18
MVE10-58-2	NMM-3 Grt 1 (0.5)	0.5	1.45
MVE10-58-2	NMM-3 Grt 2 (0.5)	0.5	1.36
MVE10-58-2	NMM-3 Omp (0.8)	0.8	0.36
MVE10-58-2	NMM-3 Epi (1.2)	1.2	XX
MVE10-58-2	NMM-3 Mus (non mag)	non mag	0.53

Figure 3: Petrographic analysis showed various stages of thermal overprint over the HPLT samples. MVE07B-12-1 shows a high temperature overprint with HPLT omphacite replaced by amphibole.

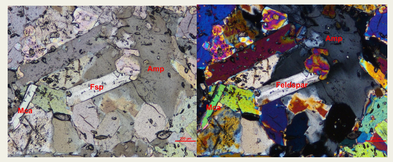


Figure 5: Modal abundance followed by whole rock calculations suggest each sample has a mid-ocean ridge basalt parent rock.

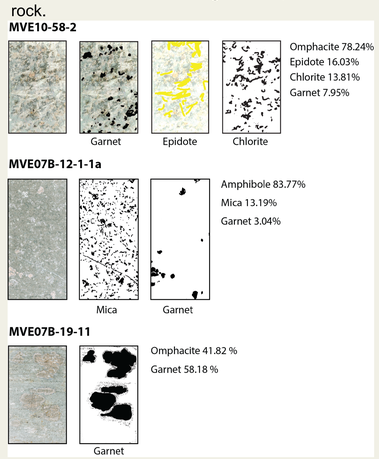


Figure 4. Electron microprobe analysis Triangular Plot to show that the garnets in each sample suggest a similar ocean basalt source.

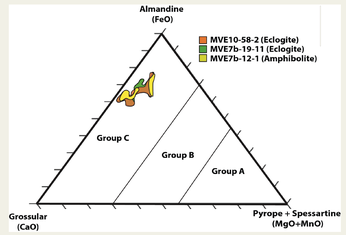


Figure 5: Electron microprobe analysis showed the garnets in each sample had similar compositions suggesting a similar ocean basalt source. The large garnet's minerals in each sample showed minimal zoning with homogenous compositions between core and rim).

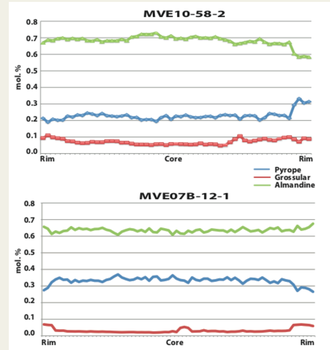


Table 2: Xray diffraction identified the two eclogite samples contained garnet, omphacite and muscovite. One eclogite (MVE10-58) also contained chlorite and clinozoisite. The other eclogite (MVE12-1) contained the high pressure mineral glaucophane. The amphibolite contained garnet, hornblende and muscovite.

Composition	Almandine	Amphibole	Clinozoisite	Epidote	Glaucophane	Grossular	Hornblende	Pyrope	Spessartine
MVE07B-10-58	✔	✔	✔	✔	✔	✔✔	✔	✔	✔✔
MVE07B-12-1	✔	✔✔			✔✔	✔✔✔		✔	✔
MVE07B-19-11	✔✔✔				✔✔✔✔	✔		✔✔	✔

Discussion

Through the various methods we used to analyze the samples, we have established that all three samples are consistent with mid-ocean ridge basalt rock formation, which was their origin prior to undergoing metamorphism. Each sample records a different uplift history: sample MVE07B-19-11 has retained its original HPLT eclogitic mineral arrangement, sample MVE10-58-2 records a lower pressure/temperature overprint as evidenced by the presence of chlorite and clinozoisite, and sample MVE07B-12-1 records a high temperature overprint shown by the presence of amphibole. This information along with the future dating results from Dr. Flores can be compared to previous samples studied from the area and will serve to further refine tectonic models for this geologically critical area's history.

Acknowledgements

Thank you to Dr. Rondi Davies, Dr. Kennet Flores, Dr. George Harlow, Brian Levine, Oscar Pineda, and the rest of the AMNH education and SRMP staff, NASA and the American Museum of Natural History.

The Science Research Mentoring Programs are supported by the National Science Foundation under Grant No. DRL-0833537, and by NASA under grant award NNX09AL36G.