THE SPECTRAL PROPERTIES OF ANGRITIC BASALTS.  T. H. Burbine¹ and T. J. McCoy², ¹Astronomy Department, Mount Holyoke College, South Hadley, MA 01075, USA (turbine@mtholyoke.edu), ²Department of Mineral Sciences, National Museum of Natural History, Smithsonian Institution, Washington, DC 20560, USA.

Introduction: One type of material that tends to be relatively rare in our meteorite collections is basalt. Basalts are rocks rich in calcium-rich plagioclase feldspar and augite pyroxene that form as solidified lava. One meteorite group, the angrites, is primarily basaltic in origin and make up 0.1% of all meteorite falls. These meteorites are composed predominately of anorthite, Al-Ti diopside-hedenbergite, and Ca-rich olivine. The type specimen, Angra dos Reis, is compositionally anomalous compared to other angrites since it is composed almost entirely of Al-Ti diopside-hedenbergite with only rare plagioclase.

The eucrites are the most common type of meteoritic basalt and appear genetically related to theHowardites and diogenites (HEDs). HEDs show continuous variations in mineralogy and chemistry and almost all are believed to have formed on the same parent body. Eucrites contain primarily anorthitic plagioclase and low-Ca pyroxene with augite exsolution lamellae.

Jurewicz et al. [1] found that partial melts of carbonaceous chondritic material resembled either angrites or eucrites, depending on the oxygen fugacity during melting. Relatively oxidizing conditions produced partial melts similar to angrites while relatively reducing conditions produced partial melts similar to eucrites. Iron meteorites are generally believed to represent ~50-70 differentiated parent bodies; however, it is unclear if angritic- or HED-like surfaces were more common. The ~500-km diameter 4 Vesta and a number of much-smaller asteroids (called Vestoids) have reflectance spectra similar to the HEDs. Almost all Vestoids are thought to be fragments of Vesta.

The identification of possible angritic parent bodies was hampered by the fact that the only previously measured angrite, Angra dos Reis [2], has a spectrum unlike any known asteroid. The spectrum of Angra dos Reis is much redder (reflectance increasing with increasing wavelength) than almost all measured asteroids. Recently, the discoveries of two relatively large angrites (D’Orbigny and Sahara 99555) plus previously discovered Antarctic angrites (LEW 86010 and LEW 87051) have allowed for the measurement of the spectral properties of meteorites that may be more typical of the surface compositions of the angritic parent bodies.

Samples: Room temperature reflectance spectra for Angra dos Reis, D’Orbigny, LEW 86010, and Sahara 99555 were obtained using the bi-directional spectrometer at the Keck/NASA reflectance laboratory (RELAB) facility located at Brown University. These samples were ground with a mortar and pestle and sieved to particle sizes less than 125 µm for the Angra dos Reis, D’Orbigny, and Sahara 99555 samples and less than 74 µm for the LEW 86010 sample.


Reflectance Spectroscopy: The room-temperature reflectance spectra of D’Orbigny, LEW 86010, and Sahara 99555 have similar spectral characteristics. Both have broad features centered near 1 µm and very weak absorption bands centered at ~2 µm. This is in contrast to the strong 2 µm band present in the Angra dos Reis spectrum. The spectra of D’Orbigny, LEW 86010, and Sahara 99555 are relatively red, but not as red as the Angra dos Reis spectrum.

The presence of a 1 µm band but a very weak 2 µm feature is characteristic of some high-Ca pyroxenes where iron is located almost entirely in the M1 site. Calcium is found in the slightly larger M2 site. These pyroxenes have two absorption bands centered at ~0.90 and ~1.15 µm that partially overlap; however, the presence of olivine in these angrites wipes out this structure in the angrite spectra.

Asteroid Spectra: Currently, no asteroid has been found to be a suitable spectral match to the angrites. Asteroids classified as Sr in the Bus and Binzel [7] taxonomy have visible spectra that match angrites, but do not spectrally match angrites in the near-infrared. Many asteroids with distinctive olivine absorption bands (such as A types) have similar spectral slopes to the newly measured angrites; however, angrites do not have these distinctive olivine bands.

Conclusions: The parent body or bodies of the angrites had to have existed in the asteroid belt, but presently no spectral analogs to the angrites have been identified.