CONSTRAINTS ON THE LITHOLOGICAL VARIATION NEAR THE SURFACE OF THE HED PLANETOID FROM THE PETROLOGY OF 91 & 92 SERIES ANTARCTIC ACHONDRITES.

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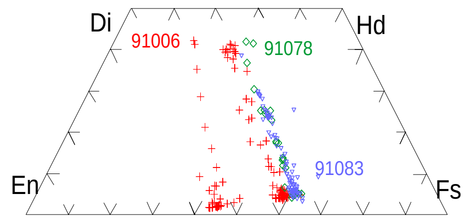
Introduction: The petrography of a suite of meteorite sections: PCA91006,14; PCA91078,9; PCA91083,6; PCA91159,4; PCA91179,9; PCA91245,9; EET92003,14; EET92004,12; EET92015,4; EET92022,7; EET92026,4; and EET92027,5 is used as an initial sample of the lithological variation on the surface of the HED planetoid (presumably 'asteroid' 4 Vesta). These samples will be combined with much larger arrays of petrographic data for the many Antarctic basaltic achondrites to provide a 'random' sample of the surface of the body. The full variety of the lithologies existing on the parent body is only accessible when the polymict achondrites are considered. The polymict samples contain lithologies that sample multiple provenances as well as those not seen as monolithologic meteorites like eucrites and diogenites. Comparison of lithological variation within individual meteorites provides a subset of variations at the site of last impact. In aggregate, the variations within the achondrites now available may be close to a random sample of the parent body. In combination of microanalytical and imaging techniques now available permit a mass balanced assessment of the distribution and abundance of lithologies to be made. These initial results provide a description of methodology to be tested.

Methods: All samples were studied and photographed on a polarizing microscope to provide location information. Major mineral phases and randomly selected points (on lines and grids) were analyzed in each thin section. In addition backscattered electron and X-ray imaging of clasts and sections provide the basis for high precision modal analyses of the abundance and distribution of both lithic and mineral clasts. These data provide objective, area based comparisons with other Antarctic samples.

Results: Meteorites 91078, 91245, and 92004 are unbrecciated eucrites. Samples 91083, 91179, 91006, 92026, and 92003 are brecciated eucrites. Samples 91159, 92015, 92022, and 92027 are polymict, howardites and polymict eucrites.

PCA91006 is a remarkable dimict breccia with lithic clasts that range from medium- to fine-grained in a very fine-grained matrix. Some larger grains are concentrically zoned, suggesting alteration after they were incorporated in the breccia. The pyroxenes fall on two distinct tie lines at $En_{55}Wo_{3-43}$ and $En_{39}Wo_{3-43}$ with little overlap of trends (Fig. 1). The Mg rich pyroxenes appear to be scattered throughout the matrix. Plagioclase ranges from $An_{81}Or_{1.3}$ to $An_{92}Or_{0.2}$

PCA91078: This sample has medium grained, well-developed heavily clouded grains of pyroxene and plagioclase. The pyroxenes ($En_{35}Wo_4$-$En_{25}Wo_{42}$) define a good tie line (Fig.1). Plagioclase varies from $An_{72}Or_{2.4}$ to $An_{94}Or_{0.4}$ and 1-2mm SiO_2 plates present. The pyroxene shows strong polygonization in several grains with coarser clouding arrays as a result.

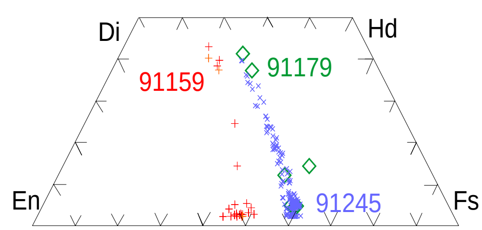


PCA 91083: This sample is an extremely fine grained, unbrecciated eucrite although autoliths of varying grain size exist. There are vesicles towards the center of the thin section, but for the most part, it is uniformly fine grained. The pyroxenes fall on a tie line ($En_{35}Wo_3$ – $En_{23}Wo_{38}$). Plagioclase is $An_{78-92}Or_{2-0.2}$.

PCA 91159: This unusual eucrite has a wide variety of grains that range from very fine grained matrix material to medium sized pyroxene and plagioclase grains $An_{87-92}Or_{0.2-0.6}$). Lithic clasts are less abundant than in more Fe-rich breccias. Both minerals are clear with minor clouding. Pyroxene is homogeneous on a tie line from $En_{54}Wo_2$ to $En_{36}Wo_{42}$. Many of the larger grains exhibit irregular fracturing and/or exsolution. Compositionally the pyroxene and plagioclase overlap the fields of cumulate eucrites but plagioclase is only ~20% vol. of the sample.

PCA 91179: This sample is a typical brecciated eucrite with a very fine-grained matrix surrounding several medium-sized lithic clasts of pyroxene ($En_{28-37}Wo_{4-42}$) and plagioclase ($An_{86-92}Or_{0.4-1}$).

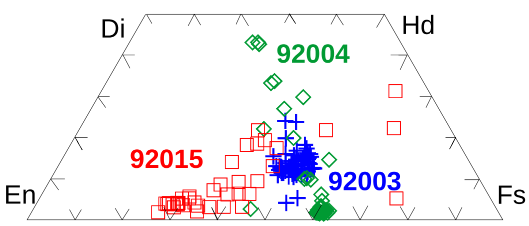
PCA 91245: This sample is an unbrecciated eucrite with exsolved medium sized pyroxene ($En_{30-39}Wo_{2-40}$) and plagioclase ($An_{76-92}Or_{0.1-1.6}$) grains amongst some small, very fine-grained matrix. Many of the pyroxene crystals also show both relict Ca-zoning and exsolution.



*EET 92003:*This is a brecciated eucrite with fine to v.fine grained lithic clasts within a very fine-grained matrix material. The grain size of many larger lithics is finer than much of the matrix, while mineral clasts tend to coarser. The pyroxenes in this sample cluster around $En_{40}Wo_{10}$ with a range from $En_{32-44}Wo_{4-24}$. Feldspar varies from $An_{81}Or_{1.4}$ – $An_{92}Or_{0.2}$. Minor elements (Cr,Ti, Mn, Al,Na) in pyroxene also cluster suggesting homogenization.

EET 92004 is an unbrecciated medium grained eucrite with notable dark veins presumably of impact melt. The grains vary in size from fine-grained to medium-grained, are irregularly shaped and are mainly composed of pyroxene ($En_{29-39}Wo_{1-43}$) along a tie line and plagioclase ($An_{74-94}Or_{0.2-9.34}$). The low Wo pyroxenes are much more abundant than high Wo lamellae. Feldspar compositions are highly variable 'anomalous' Or ranging from 0.2 to 9.0%. In the latter case Or exceeds Ab content an unusual feature presumably associated with shock & thermal resetting of the feldspar structure.

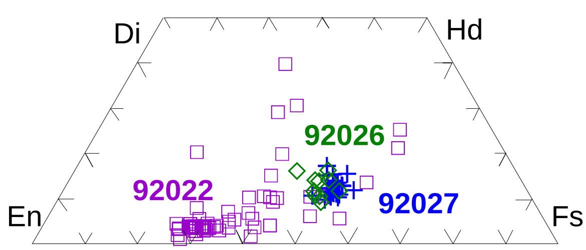
EET 92015: This is a howardite with medium- to fine-grained pyroxene grains surrounded by a very fine-grained matrix. Feldspar (An_{81-87}) is only 10-15% vol of the rock. Pyroxene clasts that dominate the section showed a very tight cluster at En_{70-72} – diogenite compositions. Other pyroxene lie in a looser array ($En_{7-72}Wo_{2-31}$) across the quadrilateral to eucritic compositions and beyond. Fe-Mn-Mg plots for pyroxene reveal lower Fe/Mn in more magnesian grains.



EET 92022: This sample is also a howardite with medium- to fine-grained lithic clasts within a very fine-grained matrix material. This sample has a variety of lithic clasts with textures ranging from porphyritic glass to subophitic basalts. Many of the pyroxene crystals ($En_{17-74}Wo_{1-40}$) show both zoning and exsolution. Diogenitic compositions are again dominant but a variety of compositions can be found in the basaltic lithic clasts and vitrophyres. Analysis of pyroxenes across on single zoned crystal show a tighter compositional line connecting pyroxenes at about $En_{75-60}Wo_{2-4}$ indicating that the grain equilibrated partially with the matrix.

EET 92026: This sample is a brecciated eucrite which has coarse to fine grained homogenous pyroxene ($En_{32-42}Wo_{10-17}$) and plagioclase crystals ($An_{85-90}Or_{0-1}$) within a darker, very fine grained matrix.

EET 92027 is represented by a very small thin section (,5) but has medium- to fine-grained lithic clasts within a very fine-grained matrix, as well as a fusion crust. The pyroxenes fell in a small compositional range around $En_{32-43}Wo_{5-15}$. In many respects this resembles EET92026.



DISCUSSION: The Antarctic basaltic achondrites probably represent as nearly a random sample of the surface of their parent body as any available. However, small sample sets such as those described can easily be biased. The samples are dominated by monomict eucrites but even among these one (91159) is of an uncommon type. In addition PCA91006 is an unusual dimict breccia. The two polymict breccias show considerable compositional variablility among both their lithic and mineral clasts. The lithological variations represented by lithic and mineral clasts within these meteorites can therefore also be random samples of the parent body surface. To assess the abundance of rock types on the surface of the HED planetoid we clearly need to incorporate a more comprehensive suite of meteorites that appear to sample the entire surface of the body, OR meteorites that contain samples of the lithologies present. If, in ideal circumstances, both types of sample suites are available, then each provides a check on the other. The several hundred available HED samples from American, Japanese and European collections represent the most comprehensive sample of any differentiated planet so far recognized among meteorites. They represent the ideal suite to use for comparing lithologies within meteorites with those represented by the entire available suite.

Descriptions of the individual achondrite lithologies, present within single meteorites, still lag behind the generalized descriptions of individual meteorites. Detailed lithological descriptions of lithic clasts and to a lesser extent mineral clasts are critical for identification of rock types not known as distinct meteorites. Such individual descriptions are impractical in a condensed format such as this, but are well suited for presentation on a medium such as the internet. A web site of lithic clast petrography is under development and should be available at Rutgers Geology by LPSC meeting time. Detailed study using a combination of quantitative imaging techniques and point microanalysis provides the methodology needed to study each sample. An important issue in the study of lithology will be to determine the importance of impact-generated rocks relative to primary igneous differentiates. However, impact melts provide average compositions of different regions of the planetary crust and hence should not be relegated to minor roles and provide a complementary dataset to those already discussed.

By identifying both the variety of rock types present in the polymict samples and quantifying the abundance of those rock types relative to the lithologies represented in the entire HED suite it will be practical to estimate the true distribution of lithologies and possibly the provenance of the lithologies on the achondrite planetoid. Finally, the results of this synthesis can be compared to the data from asteroid remote sensing to provide precise constraints on the IR spectral variations and explanations of the albedo variations present in HSS imagery of 4 Vesta.

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