NORTHWEST AFRICA 6414 CLASSIFIED AFTER 10 YEARS: A COMPLEX POLYMICT EUCRITE OF AT LEAST NINE LITHOLOGICAL GROUPS

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Introduction: Northwest Africa (NWA) 6414 has recently been officially classified as a polymict eucrite after ten years of provisional classification. Classification of NWA 6414 was carried out at Plymouth Electron Microscopy Centre. This meteorite has a total mass of 432 g, all of which has been sold to collectors and researchers aside from the 23.9 g type specimen held at the Muséum National d'Histoire Naturelle, Paris. Polymict eucrites contain numerous lithologies which record a wide range of asteroidal igneous and metamorphic processes that may otherwise not be directly sampled. The sample of NWA 6414 used in this study contains at least nine lithological groups distinguished by texture and composition, and with varying degrees of shock metamorphism. Here, we share preliminary results from scanning electron microscopy (SEM). Analysis of this complex breccia is ongoing.

Methods: A polished block of NWA 6414 was coated in carbon and analysed using a JEOL JSM-7001F FE-SEM equipped with an Oxford Instruments X-Max 50 mm^2 EDS detector and AZtec v.5.1 software. Analysis was carried out at accelerating voltage 15 keV, working distance 10 mm. BSE and EDS maps of the whole sample were collected and later combined in Adobe Photoshop to create mineralogy maps and to calculate modal abundance [1]. Standardised EDS point spectra were collected across the sample, and mineral endmember compositions calculated and compared to those of eucrite and diogenite literature [2].

Results & Discussion: NWA 6414 is composed of a dominant fragmental matrix and numerous well-defined fine-grained clasts <3 mm in size. We divide the clasts into the following broad categories based on composition and texture, summarized in Table 1: subophitic, shocked subophitic, equigranular, fayalite-rich, granulitic, symplectite, melt, sulfurized [3], metal-troilite networks, and breccia-in-breccia. Two pyroxene thermometry [4] shows that the lithological groups experienced distinct peak metamorphic temperatures that are elevated compared to estimates of Vesta's global crustal metamorphism [5], likely as the result of shock. Shock-related metamorphism appears to disrupt typical eucritic compositional trends, causing extended ranges of major and minor element components in pyroxene that is best observed in the shocked subophitic and symplectite clasts. The diversity of shock and metamorphic features observed in NWA 6414 in conjunction with the restriction of such features to specific clasts, we infer that NWA 6414 represents lithified ejecta generated from multiple impact events and records a wide range of impact-related processes on the HED parent body.

Table 1. Brief summary of lithological groups observed in NWA 6414

	Sub-Types	Pyroxene	Plagioclase	Fayalite	Peak T °C [4]	Notable Features
Subophitic	1	$Fs_{34.1-63.8}Wo_{8.8-37.9}$	$An_{83.9-95.0}Or_{0.1-2.0}$	-	1207	Largest clasts
Shocked Subophitic	3	$Fs_{30.0-87.7}Wo_{0.5-44.7}$	$An_{85.1-95.60}Or_{0.4-1.9}$	$Fa_{78.6-86.6}$	1770	Extensive pyroxene zoning
Equigranular	1	$Fs_{32.4-38.5}Wo_{35.2-41.1}$	$An_{91.5-94.7}Or_{0.2-0.6}$	-	1196	Broad pyroxene exsolution lamellae
Fa-Rich	3	$Fs_{44.1-44.7}Wo_{39.3-39.7}$	$An_{86.0-87.8}Or_{1.3-2.0}$	$Fa_{80.6-81.3}$	1347	Occurs in conjunction with abundant silica
Granulitic	2	$Fs_{32.0-73.6}Wo_{4.4-37.4}$	$An_{94.2-95.6}Or_{0.2-0.5}$	$Fa_{73.9-77.3}$	1155	Well-formed triple junctions
Symplectite	2	$Fs_{38.1-69.2}Wo_{22.1-45.0}$	$An_{82.7-97.0}Or_{0.3-3.1}$	$Fa_{65.2-91.1}$	1694	Typically Px + Fa + Si
Melt	2	$Fs_{45.9-53.8}Wo_{23.1-34.5}$	$An_{81.5-85.1}Or_{1.9-4.0}$	-	1119	Dendritic/skeletal silicates
Sulfurized	1	$Fs_{48.6-51.9}Wo_{44.6-46.3}$	-	-	1693	Sulfurization [3] restricted to specific clasts
Metal-Troilite Networks	1	$Fs_{35.0-60.5}Wo_{1.3-26.7}$	$An_{88.5-96.40}Or_{0.3-1.2}$	-	1172	Angular grain fragments with altered pyroxene rims
Matrix/Breccia-in-Breccia	2	$Fs_{23.3-66.8}Wo_{3.8-40.2}$	$An_{83.6-97.5}Or_{0.1-1.7}$	$Fa_{76.2-80.1}$	1576	Mineral fragments. Br-in-Br clasts are finer grained than matrix

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