

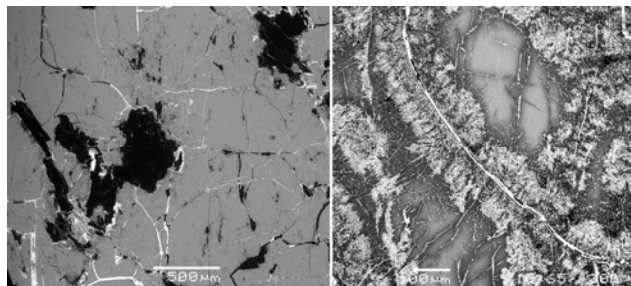
## CLASSIFICATION OF SECONDARY REDUCTION TEXTURES IN UREILITES

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**Introduction:** Ureilites are primitive achondrites dominated by olivine and pigeonite, with minor augite, orthopyroxene, graphite, sulfide and metal [1]. After classifying several dozen ureilites, we observed a pattern of increased reduction of olivine and to a lesser extent, pyroxenes, with concomitant loss of graphite and increased degree of hardness. From these observations, we have developed a new classifying element useful in distinguishing various types of ureilites.

**Methodology:** We recognize four stages of reduction based upon the volume ratio of graphite to reduction rim metal, and the thickness of the reduction rims on olivine. Those ureilites that have unreacted graphite and very lightly reduced silicates are assigned lowest reduction grade, R1. Ureilites where no graphite remains and olivine rims are heavily reduced with over 50 vol. % of grain mass affected, are assigned highest grade, R4.

	R1	R2	R3	R4
Graphite/metal (vol. %)	>10	10-1	<0.5	0
Rim thickness of reduced olivine (mm)	<15	15-50	50-150	>50 vol. % of olivine
Degree of hardness	soft	med	hard	Extreme
Carbides & Diamonds	none	none	carbides	Diamonds & carbides



Backscattered electron images. (left) NWA-1834; grade R1 with large patches of graphite. (right) NWA-2376; grade R4 extensively reduced with no residual graphite.

**Interpretation:** Secondary reduction rims on olivine in ureilites are commonly agreed to result from a sudden drop in pressure (hence carbon-controlled  $fO_2$ ) and temperature, most likely to due to impact excavation during parent body break up [1,2,3]. The factors that might lead to such varying degrees of this reduction in observed samples are not clear (there is, for example, no correlation with core Fo, hence no apparent correlation with original depth), but may be related to the size of the fragment in which each sample was embedded during this event [3]. The correlation of diamond occurrence with other indications of increased reduction suggests a role for shock, although in general we do not observe any correlation with other shock features.

**References:** [1] Mittlefehldt D.W. et al. (1998) *Rev. Mineral.* 36, 4-1-4-195. [2] Warren P.H. and Huber H. (2006) *Meteorit. Planet. Sci.* 41, 835-849. [3] Goodrich C.A. et al. (2004) *Chemie de Erde* 64, 283-327.