KENNA

Ureilite, group 1

calcic, high FeO, low ^{16}O, high ^{17}O and ^{18}O

Found February 1972
33° 54' N., 103° 33.2' W.

A single stone of 10.9 kg was found in Roosevelt County, New Mexico by Ivan "Skip" Wilson on his ranch. It is composed mainly of olivine and the calcium-poor pyroxene, pigeonite, in a black carbon-rich matrix composed of graphite, lonsdaleite, and diamond. Melt pockets and secondary veins contain grains of augite, andesine, K-feldspar, diopside, and chromite. Kenna is a member of the least reduced group 1 being FeO-rich and having a high fayalite content.

The predominance of pigeonite over orthopyroxene suggests formation of ureilites as cumulates from a basaltic magma. The preferred orientation of the coarse pigeonite grains are also evidence of a cumulate plutonic origin. However, competing theories would have ureilites forming as primitive residues by single-stage equilibrium partial melting. Since the Ca/Al ratio in pyroxenes is substantially higher than chondritic levels, a plagioclase-depleted parent magma would have been required. Also, various other elemental ratio correlations would require the existence of many complementary rock types, none of which are found in our collections. Therefore, the exact nature of the ureilite precursor material and its complex history will have to await further research on an ever-increasing ureilite collection.

The microscopic diamonds and lonsdaleite found in Kenna were probably formed by the impact shock forces that liberated this meteorite from its parent body. Correlation between the carbon and O-isotopic compositions among the ureilite groups implies that the carbon was indigenous to the source rocks and was not introduced later through impact-melt injection. Previous theories have supported multiple mass-injection events from carbon-rich planetesimals for the formation of the carbonaceous veins and for the source of noble gas and nitrogen components.

Current examinations of the graphite/diamond relationships found in Kenna and other ureilites using x-ray diffraction techniques have revealed the presence of compressed graphite. Compressed graphite has been known to occur experimentally under high pressures as part of the phase transition to diamond. Furthermore, there is a correlation with the ratio of graphite to diamond and the shock level as estimated from the shock features of the silicates. This research provides solid evidence for the formation of diamonds in ureilites as a result of the high-pressure conversion of graphite to diamond during an impact event.

The ureilite parent body is thought to have been 50-100 km across with a composition similar to C3 carbonaceous chondrite material that underwent a reduction phase, possibly as a result of impact excavation, resulting in a depletion in iron and siderophile elements. Models suggest that following igneous and metamorphic phases, the ureilite parent body was disrupted by a major impact and rapidly cooled. The above specimen is a 3.5 g partial slice.