GOLD BASIN METEORITE STREWN FIELD: THE "FOSSIL" REMNANTS OF AN ASTEROID THAT CATASTROPHICALLY FRAGMENTED IN EARTH'S ATMOSPHERE -

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A new meteorite strewn field has been discovered in the Gold Basin region of the Mojave Desert in northern Arizona. Extensive field work during a 2 year period has recovered more than 2000 specimens over a 50 square mile area. Petrographic and electron microprobe analyses indicate that the meteorite is a type L4 ordinary chondrite, although it also contains clasts of at least one other type of meteoritic material. An L4 classification and the name Gold Basin have been approved by the Meteorite Nomenclature Committee [1]. Preliminary cosmogenic nuclide studies indicate the meteorite fell during the last ice age, 20,000 to 25,000 years ago.

The Gold Basin meteorite was discovered by J.D. Kriegh while prospecting for gold with a metal detector on 24 November 1995 in the eastern portion of the Mojave Desert. The initial find consisted of two fragments (~13 g total mass) which were immediately identified as meteoritic material by one of us (DAK). From the morphology of the fragments, it was clear that they were part of a larger object. Subsequent field studies by Kriegh, J. Blennert, I. Monrad, and DAK have recovered more than 2000 fragments as of January 1998. Most of these fragments were found using metal detecting techniques. Because the samples are often the same size and color as other desert pavement constituents, or lie buried beneath the surface (up to 10 inches deep), visual identification is difficult. Samples exposed on the surface are sometimes coated with desert varnish, while those that are buried are often encased in caliche. Fusion crust is variably preserved, except on some fractured surfaces where it is clear that it was never present, indicating that the asteroid fragmented low enough in the atmosphere and/or at low enough speeds for the freshly fractured surfaces to remain relatively unheated.

Saw cuts expose a variegated gray to black silicate interior and obvious inclusions of metal. Thin-sections reveal readily delineated chondrules in a matrix that is largely (but not completely) transparent and is dominated by microcrystalline material. Olivine is homogeneous with a composition of $Fa_{24\pm1}$. Pyroxene is typically $Wo_1En_{79}Fs_{20}$, although rare pigeonite ($Wo_9En_{72}Fs_{18}$ to $Wo_6En_{75}Fs_{19}$) and augite ($Wo_{40}En_{50}Fs_{10}$) were also encountered. Pigeonite has the same Mg# as the low-Ca pyroxene grains and, as usual in chondrites, the pyroxene has a slightly higher Mg# than neighboring olivine. Polysynthetic twinning of pyroxene is common. Kamacite contains 0.72±0.09 wt% Co. These compositions and textures are similar to those in type L4 chondrites [2,3].

Samples of 6 individual fragments of the meteorite were studied for the ^{14}C composition using the methods of [4]. These meteorites were found to have ^{14}C contents ranging from 1.8±0.3 to 4.6±0.3 dpm/kg. This range of values is consistent with samples representing different depths in a body with radius 50-80 cm, and a terrestrial age of about 20-25 ka. ^{10}Be studies are underway on the same samples to determine ^{14}C production rates from ^{10}Be, analogous to the work of [5]. ^{14}C in the L5 chondrite Knyahinya, a known fall, ranged from 37 to 57 dpm/kg in this body which had an estimated pre-atmospheric radius of about 45 cm (see [6]). The range observed for the new meteorite suggests a much larger object than Knyahinya.

The terrestrial age of the Gold Basin meteorite indicates the fall occurred in the Late Pleistocene, during the Late Pinedale portion of the Wisconsin glaciation. Currently, the area of the strewn field is fairly arid, composed of Joshua trees and desert scrub. At the time of the meteorite fall, the area had relatively wet winters and mild summers, which allowed woodlands, mixed with warm desert species, to grow at lower elevations [7,8]. Despite the additional moisture, most of the meteorite fragments managed to survive largely intact, although some were either split on impact, or subsequently split by weathering processes, to form small clusters of fragments that can be reassembled. The weathering state of the meteorite is typically W2 to W3 [9], although it varies considerably in the strewn field. This is probably a function of where each stone landed. Some samples are on mountain slopes, while others are in drainage systems, plus the nature of the soil and depth of burial are variable.

The field team has been carefully mapping the distribution of fragments as a function of mass, but they have not yet found any features in the distribution that would indicate the trajectory of the asteroid. Neither has the team reached the limits of the strewn field, even though they have mapped stones over a 50 square mile area. Consequently, we are currently unable to calculate the height of the explosion. The smallest fragments in the field are the most numerous (Fig. 1) and the largest mass is 1.5 kg. This is preliminary data which will need to be revised as more samples are found and the extent of the strewn field is finally determined. Assuming that we have not found the largest specimens that should occur at the downrange end of the strewn field, the average size of stone in the field should be larger than our data thus far imply.

The kinetic energy of the Gold Basin asteroid when it hit the top of the atmosphere would have been equivalent to ~10 to 1000 tons of TNT, assuming a 50-80 cm radius, a bulk density of 3.5 g/cm^3, a cosmic velocity of 11 to 20 km/s, and (erring on the low-energy side) that no mass was lost in the atmosphere. A large fraction of this initial kinetic energy would have been lost as the asteroid was decelerated in the atmosphere prior to exploding. This size of event occurs ten to hundreds of times each year (extrapolating from [10]), although most impacts of this sort occur over the ocean and rarely are fragments recovered. Among fragmenting asteroids composed of L-chondrite material, there are only 4 documented showers with a comparable or larger number of stones: Knyahinya (fell 1866, 1000 stones recovered), L'Aigle (fell 1803, ~2000-3000 stones recovered), Mocs (fell 1882, ~3000 stones recovered), and Holbrook (fell 1912, ~14,000 stones recovered) [11]. All of these other strewn fields are witnessed falls, whereas Gold Basin is a find. To our knowledge, this is the oldest strewn field in North America and, indeed the world, except for those that were preserved in antarctic ice. Interestingly, two of the L-chondrite strewn fields with the most stones occur in Arizona (Gold Basin and Holbrook). Since we expect to find many more stones in the Gold Basin strewn field, it may eventually rival the Holbrook fall in the number of specimens recovered. In any case, the Gold Basin asteroid was apparently larger than the Holbrook asteroid. The re-assembled diameter of the Holbrook asteroid is half a meter (assuming a total mass of 218.31 kg [12] and an average bulk density of 3.5 g/cm^3), which is 2 to 4 times smaller than the estimated size of the Gold Basin asteroid.

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