

**POTENTIAL FOR PRESERVATION AND RECOVERY OF FOSSIL IRON METEORITES FROM COAL, TRONA, LIMESTONE, AND OTHER SEDIMENTARY ROCKS.** A. A. Sicree<sup>1</sup>, D. P. Gold<sup>2</sup>, and K. Hoover<sup>3</sup>; <sup>1</sup>Earth & Mineral Sciences Museum, Pennsylvania State Univ., University Park, PA 16802, sicree@geosc.psu.edu; <sup>2</sup>Geosciences Dept., Pennsylvania State Univ., University Park, PA 16802, gold@ems.psu.edu; <sup>3</sup>EES Environmental Group, Story, WY 82842, doc@wave.sheridan.wy.us.

Although meteorites have fallen onto the Earth throughout geologic time, fossil meteorites or paleometeorites (*i.e.*, those which fell long enough ago to have been buried and preserved in sedimentary rocks) are quite rare. Iron meteorites oxidize rapidly, surviving only a few hundred years in most environments. Only a few fossil meteorites are known and their discoveries were largely matters of chance. The *Lake Murray* (Oklahoma) octahedrite, found in a Cretaceous sandstone, is the oldest known paleoiron [1]. Heavily corroded on the exterior, its iron-nickel core was unaltered despite its 120 million year old terrestrial age. More than one dozen Ordovician paleochondrites have been recovered from limestone quarries at Brunflo and Österplana, Sweden. These paleometeorites are heavily altered and have been largely replaced by barite and calcite [2,3].

An iron meteorite falling into a coal swamp will develop a rind of pyrite, siderite, or rust, which inhibits alteration of the interior of the meteorite. After coalification, an iron meteorite encased in coal will be preserved from further corrosion by the reduced state of the coal, particularly in a coal seam with a methane-dominated vapor phase. The discovery of native iron in coal indicates that iron meteorites could survive for millions of years in coal seams. Native iron has been reported in a Cretaceous coal from the Dutch Creek Mine, Pitkin County, Colorado, where it occurs at the coal/coke interface adjacent to an intruding felsic porphyry dike [4].

Other sedimentary environments which may have been conducive to paleometeorite preservation include those in which trona, limestone, sandstone, shale, gypsum, secondary kaolin, or salt were deposited. Trona, a sodium carbonate mineral, is particularly favorable to the preservation of metallic iron, because of the relatively high pHs and strongly reduced state of groundwaters in contact with the trona beds.

Estimates of the present-day flux of meteorites range from 100 to 1000 metric tons of meteorites per day for the whole of the Earth's surface [5], about 1% of which is recoverable or macro-meteorites, giving an average macro-meteorite flux of  $1.8 \times 10^{-7}$  g/m<sup>2</sup>yr. About 5% of these meteorites are strongly magnetic (*i.e.*, iron, or stony-iron meteorites). If coal accumulated at the rate of 0.1 mm/yr, then every million short tons of coal should yield about 300 g of magnetic macro-meteorites. A large Western U.S. coal operation such as the Black Thunder Mine in Wright, Wyoming, which mines more than 36 million tons of coal per year, could yield about 10,000 g of magnetic macro-meteorites per year. Similar theoretical yield estimates have been made for other sedimentary rocks.

By examining materials captured by existing large electromagnets (used to remove "tramp" iron, such as drill bits, from the mineral stream) suspended over conveyor belts at coal mines, it should prove possible to recover fossil iron meteorites from the coal. Efforts to recover fossil iron meteorites by this method are underway at coal mines in Pennsylvania, Wyoming, and Montana, and at trona mines in the Green River Basin of southwest Wyoming. This recovery method potentially can be applied to other sedimentary rocks such as limestone and secondary kaolin, the mines of which also often employ tramp metal electromagnets.

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