ABEE

EH Melt Breccia

Fell June 9, 1952
54° 13' N., 113° 0' W.

At 11:05 pm, people in Alberta, Canada witnessed a fireball accompanied by detonations. Five days later, a single 107 kg stone was recovered from a 3-foot-diameter, 6-foot-deep hole in a wheat field near the town of Abee, ~56 miles north of Edmonton. The meteorite was purchased from the finder by the Geological Survey of Canada.

The formation of this rock began with a violent impact event in which up to 90% of the chondrules were melted or resorbed. Enstatite crystallized from the silicate melt and kamacite-rich rims formed around the clasts and relict EH material. Large kamacite nodules crystallized from the metal-sulfide melt regions. A subsequent period of meteorite impacts shattered this homogeneous melt and mixed in an igneous, fine-grained, oldhamite-rich, dark component. Partial melting of metal and silicate also occurred. Finally, a second major melting event occurred, probably from impact, producing an enstatite melt that flooded and absorbed the smallest clasts and relict chondrules. This was followed by rapid cooling, forming the matrix and leaving the larger silicate clasts and chondrules unseparated from the metal-sulfide component.

Although E-chondrites and aubrites share a common O-isotopic signature, some chemical and mineralogical differences exist which had previously cast doubt on their formation on a common parent body. Some of these differences include the higher abundance of Ti and forsterite (Mg_2SiO_4) in aubritic sulfides than in E-chondrites. A scenario reconciling these differences has been presented in light of an experiment in which an E-chondrite was systematically melted in a very reducing, oxygen-depleted environment.

In the experiment, as the silicate melt reached a temperature range of 1000-1300°C, and the degree of partial melting reached 20%, the metal-sulfide component began to migrate out of the silicate. At 1450°C, a completely separated metal component could have established a metallic core on its parent body. Since the sulfides melted at temperatures as low as 1000°C, it was demonstrated that aubritic sulfides cannot be a product of nebular synthesis as previously speculated. Instead, tranfer of S and Ca from the S-rich silicate melts resulted in magmatic crystallization of oldhamite (CaS). Moreover, a phase was reached at 1500°C in which SiO2 was reduced to Si within the metallic melt, with the subsequent crystallization of forsterite. In addition, Ti-rich troilite crystallized from a combination of an Fe-rich sulfide melt and a mixed sulfide melt. All of the results of the experiment are consistent with a derivation of the aubrites from an E-chondrite-type precursor in a strongly reducing, oxygen-depleted environment.

Previously, employing multiple lines of evidence including chemical, petrographic, metamorphic, and cosmic-ray exposure age data, studies suggested that the EL and EH chondrites originate from different layers on the same parent body. More recently, very precise isotopic measurements were made of a statistically larger sampling of E chondrites and aubrites. Although their O-isotopic data were indeed identical, a three-isotope plot distinguished the EH group from the EL and aubrite groups by its slightly steeper slope; the plots of the EL and aubrite groups were colinear with the terrestrial fractionation line. A third grouplet with intermediate mineralogy has recently been identified, represented by the meteorite Y-793225. Studies have determined that it was not derived from the EH or EL groups through any metamorphic proccesses, and thus may represent a unique enstatite parent body. The Shallowater meteorite is also considered to originate from a unique enstatite parent body.

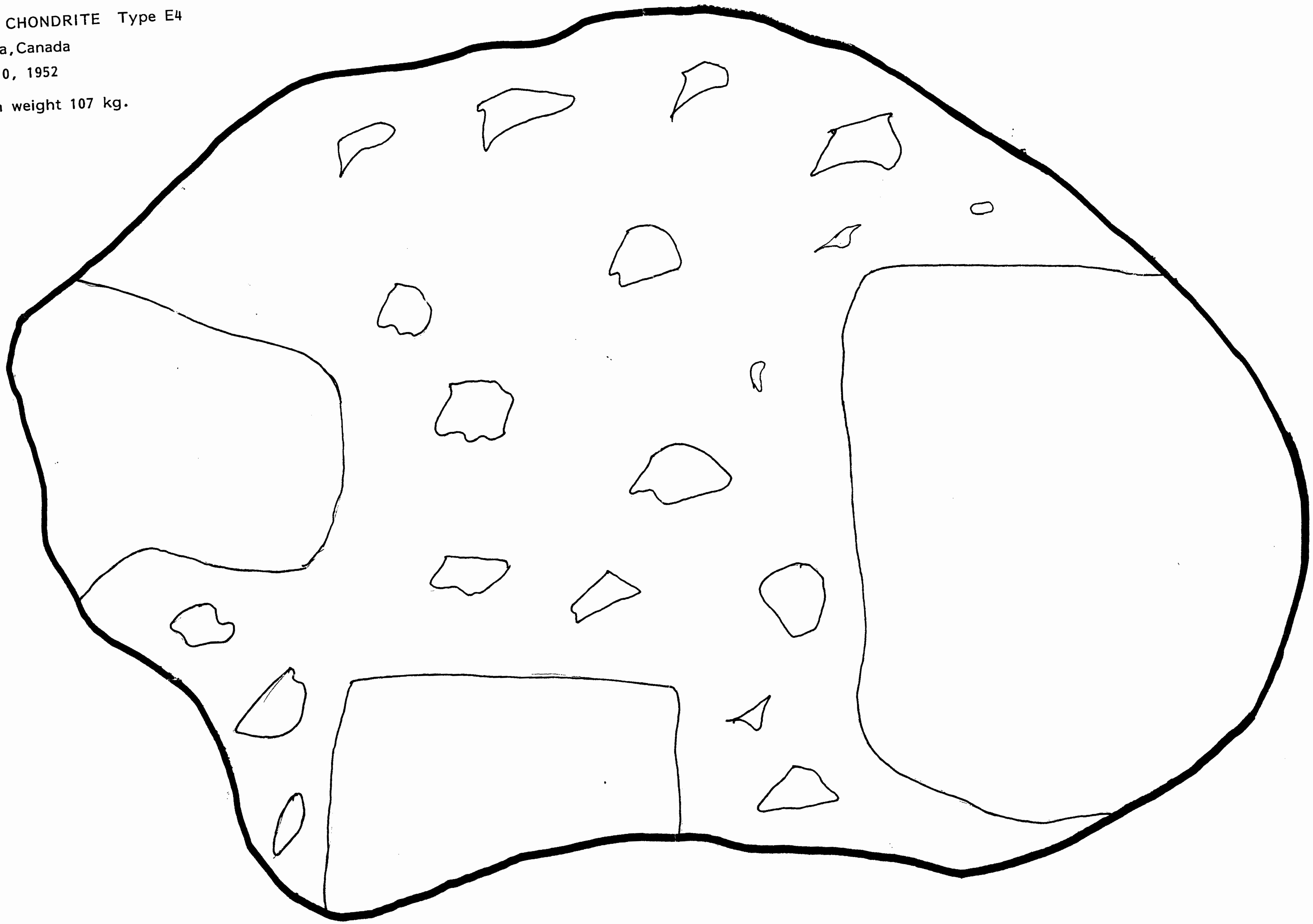
Abee's iron-rich, oxygen-poor composition, as well as its greater depletion of refractories than the Earth, has led to speculation that it may have once been a part of the predifferentiated outer layer of Mercury. However, reflectance spectrometry has identified asteroids similar to E-chondrites in stable orbits between 1.9 and 2.7 AU, suggesting the asteroid belt is where they originated. Additionally, an anomalous light N component found proportionately in carbonaceous and E-chondrites but not on Earth, and almost certainly of nucleosynthetic origin, points to a similar heliocentric location for the formation of these bodies. The specimen shown above is a 4.9 g partial slice showing the brecciated nature of this meteorite, including a metallic-rimmed clast (bottom center) and a dark inclusion of unique enstatite chondritic material (upper right).

ENSTATITE CHONDRITE Type E4

Abee, Alberta, Canada

Fell: June 10, 1952

Total known weight 107 kg.



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