PROPERTIES OF AN IRON OCTAHEDRITE METEORITE COLLECTED AT ODESSA METEORITE CRATER, ODESSA, TX

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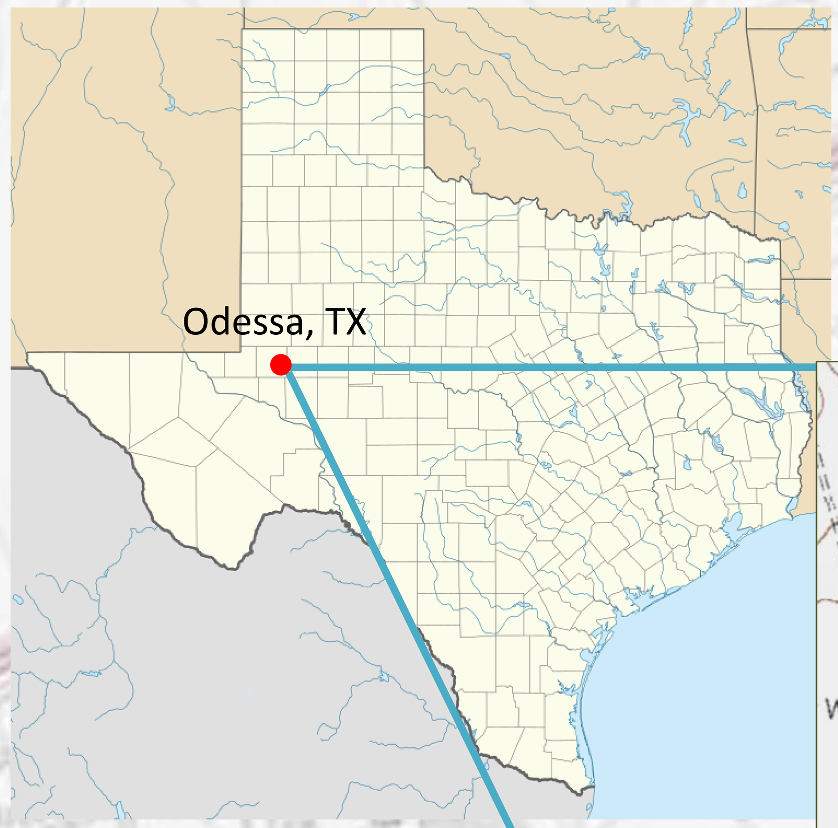
Abstract

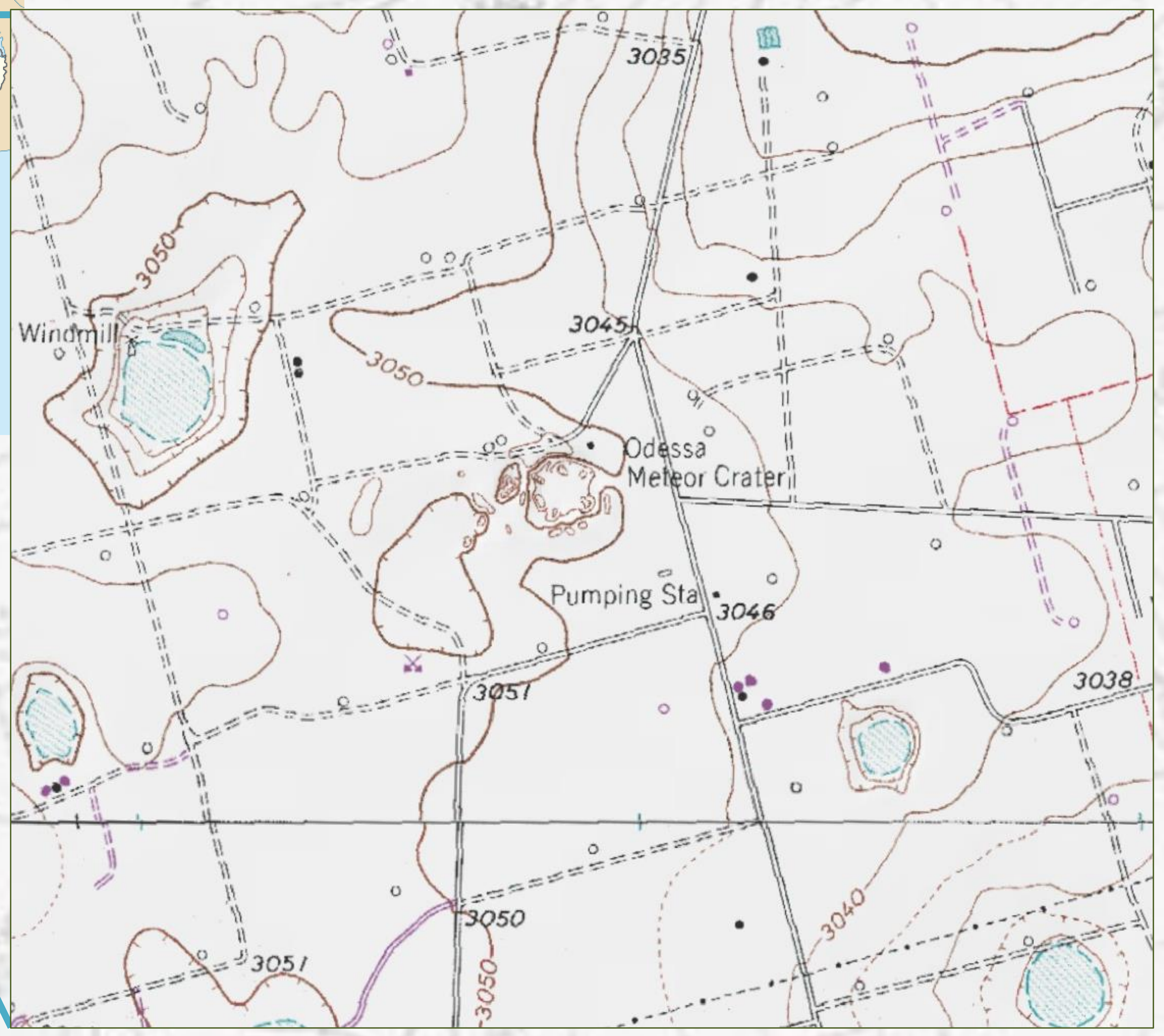
An iron octahedrite was analyzed through observations of its physical and chemical properties in order to understand and classify those characteristics common to iron meteorites. The total weight of the meteorite was 406.37 grams. It exhibits a high degree of magnetism, high specific gravity, and nickel content of at least 1.0×10^{-3}. The meteorite's surface is stained with iron oxide and covered in regmaglypts resulting from ablation during its fall through the Earth's atmosphere. A portion of the sample weighing 20.79 grams was removed in order to produce an etched, polished thin section for petrographic analysis. The area from which the thin section was cut has been highly polished and prepared to be etched with an acid solution in order to reveal a Widmanstätten pattern on the meteorite. A Widmanstätten pattern visually represents the octahedral structure in the metal formed by laminae of kamacite and taenite. Utilizing reflected light microscopy, the average kamacite band width is measured and used to further classify the octahedrite in the range of "coarsest" to "finest," as well as estimate its cooling rate. The purpose of this study is to become familiar with the process of investigating and documenting an iron meteorite's qualities.

Methods

The meteorite was collected near Odessa Meteorite Crater by Dr. Harold Povenmire. The sample was then purchased by Dr. Martha Leake for her personal collection in 1986. In fall of 2019 the sample was graciously shared with Cameron Hester to carry out this study. An analysis of its surface features and physical characteristics was performed. The 406.37-gram meteorite was photographed from all angles to document its shape prior to removing any portion. With the careful assistance of Dr. Mark Groszos, the meteorite was then cut with a rock saw to remove a 20.79g portion of material. This piece was sent to a lab that produces thin sections but has not been returned and will be analyzed using reflected light microscopy in fall of 2020. The remaining sample was hand polished with progressively finer grit until a mirror-like surface appeared. In total 11.11g of material was removed solely during the polishing process, with the final mass being 374.47g. The raw surface of a meteorite will rust quickly, so the etching solution was prepared immediately after the final polish. Under a fume hood, 0.5 grams of solid Iron (III) Chloride was dissolved into 10 grams of water to produce the etching solution. The polished face was dipped into the solution and wiped away repeatedly until the Widmanstätten pattern had fully appeared. The etched surface was then cleaned with deionized water to stop the reaction. The sample was photographed again, and sealant applied to protect the metal from oxidizing.



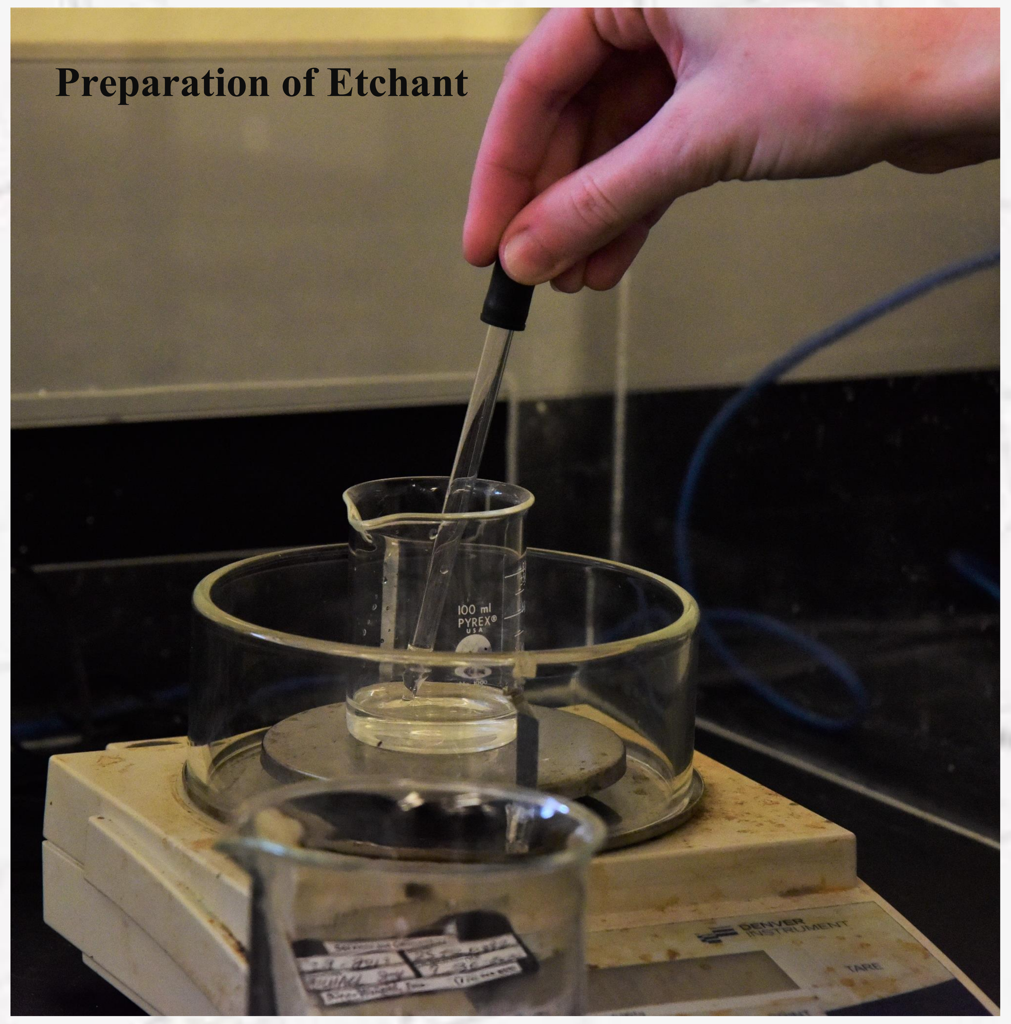
Odessa Meteor Crater is approximately 550 feet in diameter.




Original Sample


Original Sample


Removed Portion for Thin Section


Preparation of Etchant


Application of Etchant

Introduction

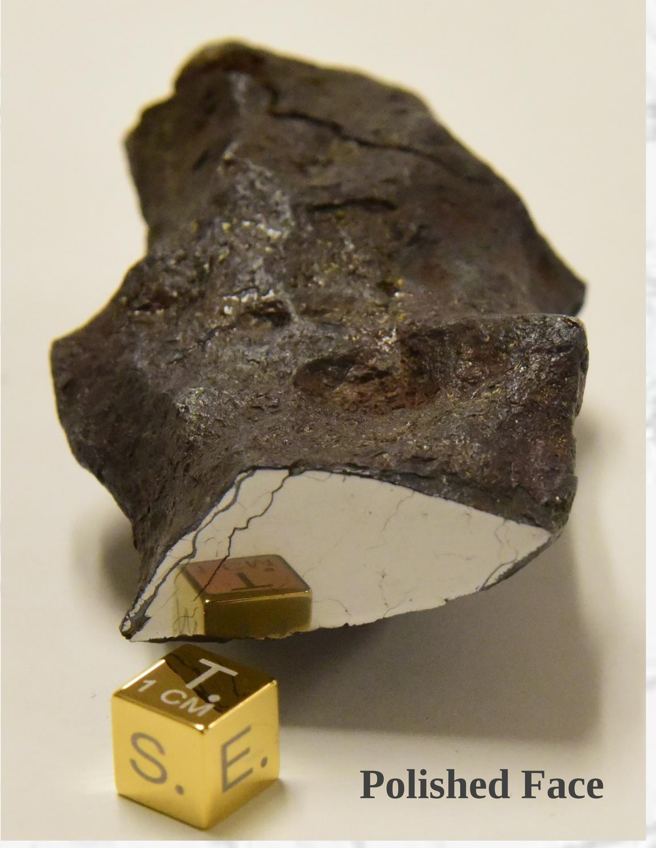
The main objective of this thesis is to explore the methods used when identifying and classifying an iron meteorite. Observing and documenting the physical properties exhibited by the meteorite are crucial to the classification process. A primary objective of this study was to produce a Widmanstätten pattern after polishing and acid etching a surface of the meteorite. This pattern reveals bands of kamacite and taenite which may be measured and quantitatively used to estimate the cooling rate of the sample. Proper care of the etched surface must be taken, so the face was immediately sealed to prevent rust and preserve the sample for future investigations.

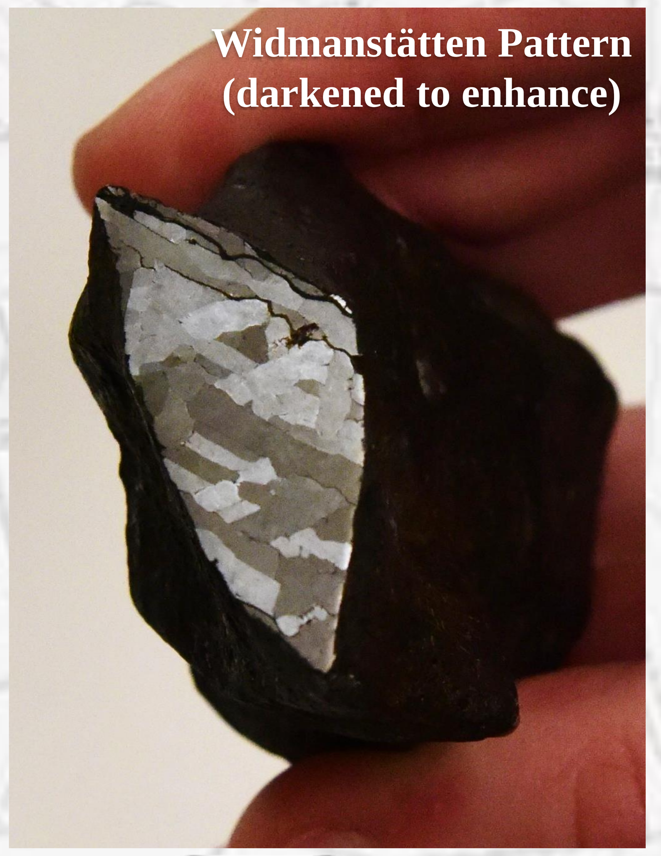
Results and Conclusions

Examination of meteoritic properties: The meteorite's dark surface is known as a fusion crust, roughly 1 mm thick, with rust covering it entirely. Indentions resulting from ablation during its fall through the atmosphere known as regmaglypts defined its overall shape. It was significantly elongated, a positive indicator considering meteorites are seldom rounded. One very prominent stress fracture and several smaller ones were observed in the sample. The meteorite was determined to be highly magnetic and demonstrated a high specific gravity. A small surface area was cleaned of rust, exposing a bright metal-colored interior. A drugstore solution called Nickel Alert was applied with a cotton swab directly to the metal; after rubbing the meteorite a red color appeared on the swab, indicating a nickel content of at least 0.1%.

Examination of Widmanstätten pattern: The Widmanstätten pattern develops inside a meteorite as the minerals kamacite and taenite undergo a two-phase intergrowth. The average width of the kamacite laminae was measured to be 1.5 mm, classifying this meteorite as a Coarse Octahedrite (Og). The total nickel content can then be estimated between 6.5-8.5%, based on the relationship between structural classification and relative abundance of nickel to iron. J. A. Wood suggested that a coarse octahedrite, like this, may have cooled at a rate of ~1℃/million years in regards to the center of its parent asteroid

Conclusions: The Coarse Octahedrite (Og) collected at Odessa Meteorite Crater chemically and physically aligns with the accepted standard of classifications for other known Odessa meteorite samples.


Polished Face


Widmanstätten Pattern (darkened to enhance)

Structural Classification	Laminae Width	Percent Nickel	Symbol
Coarsest Octahedrites	>3.3 mm	5-9%	Ogg
Coarse Octahedrites	1.3-3.3 mm	6.5-8.5%	Og
Medium Octahedrites	0.5-1.3 mm	7-13%	Om
Fine Octahedrites	0.2-0.5 mm	7.5-13%	Of
Finest Octahedrites	<0.2 mm	17-18%	Off

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