EXTERNAL STRUCTURES OF THE FUSION CRUST OF THE TRYSIL METEORITE

OLE FRIDTJOF FRIGSTAD

Frigstad, O. F.: External structures of the fusion crust of the Trysil meteorite. *Norsk Geologisk Tidsskrift,* Vol. 51, pp. 9–14. Oslo 1971.

Special features on the fusion crust of the Trysil meteorite are described and used to determine the orientation of the meteorite during the flight. On the rear side, the air movement must have been turbulent.

Ole Fridtjof Frigstad, Mineralogical-Geological Museum, Sarsgt. 1, Oslo, Norway.

On 21 June 1927 a meteor was observed over a wide area of southeastern Norway. Most of the spectators saw a fireball with a broad, glowing tail which left a smoky trail in the sky. Many of the northern observers also heard an explosion and the shock wave was so violent that window glass was broken and loose objects were blown down. I. Oftedahl (1929) collected reports of the observed phenomena, and by studying them he was able to deduce the trajectory. He pointed out that the meteorite must have fallen somewhere north of Trysil. About one month later pieces of a stony meteorite were found at a farm called Barflo in Drevdalen within Oftedahl's predicted area. The orientation of the 16 cm deep impact crater very well agreed with his deduced trajectory. The amount of material collected was 640 g, consisting of one small and two larger pieces, which could be fitted together to reconstruct the form of the impacting fragment.

The Trysil meteorite (Fig. 1) has a light-grey interior, and a dark-brown fusion crust 0.1–0.3 mm thick. Petrographical data on this meteorite are scanty. The only facts come from M. H. Hey (1966), who classifies it as an olivine-hypersthene chondrite, and B. Mason (1963) who determines the composition of the olivine to be 25% Fa. This agrees with the common range of olivine composition (Fa_{22-31}, B. Mason 1963) for this type of chondrite. A close inspection of the material also revealed that troilite and nickel-iron occur, but the amount of nickel-iron seems to be small. The low specific gravity (3.37 g/cm^3) strengthens this supposition.

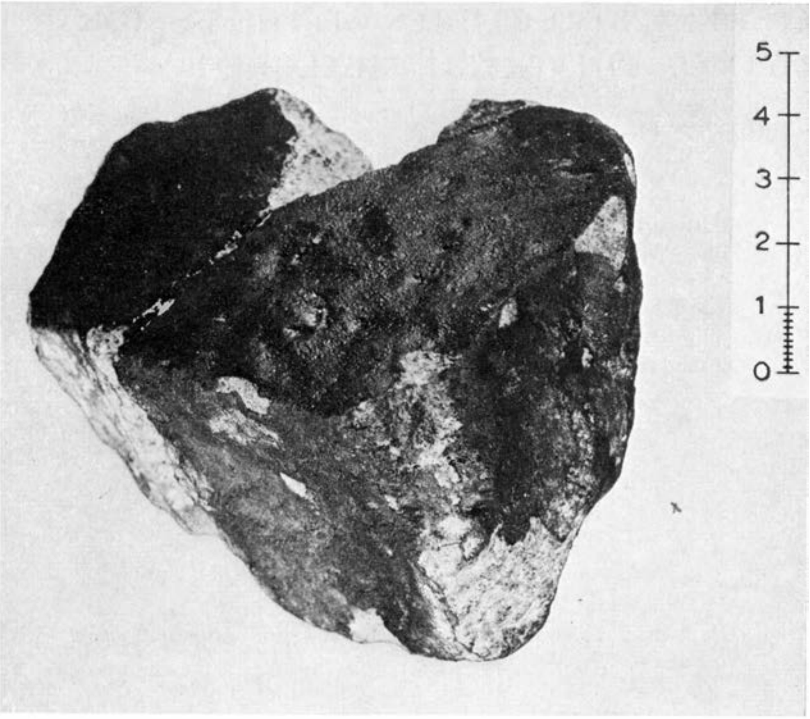

Fig. 1. The Trysil meteorite.

The reconstructed meteorite is roughly wedge-shaped. The maximum thickness of the wedge is 5.5 cm and it is 6.5 cm wide and 10 cm long. It consists of two fairly large faces which constitute the top and bottom of the wedge, and three smaller faces forming the sides of the wedge. One large face is quite planar, the other parts are gently concave and convex. Contraction cracks are developed, but only on a small scale. The edges of this meteorite are very sharp in places, particularly around the flat surface. This indicates that the Trysil meteorite is a fragment of a larger meteorite.

The break-up must have taken place within the earth's atmosphere, probably when the explosion was heard, since no possible primary surface can be found on it. With respect to the form, the flat side could look primary, but here the fusion crust is only 0.1 mm thick in contrast to a thickness of 0.3 mm on the rest of the meteorite. The relatively thin total fusion crust is possibly due to a short flight with cosmic velocity immediately after the explosion. Small pieces have apparently broken off two of the corners later in the flight, since here the fusion crust is extremely thin.

The best method for deciding the orientation of a meteorite during flight is to investigate the external structures of the fusion crust. These are well developed on the Trysil meteorite.

Fig. 2. Peaks on the front surface.

Close inspection of the uneven main side reveals many rounded triangular pyramids (Fig. 2). The edges of these often end in ridges which continue across the surrounding surface. The largest pyramids are 0.5 mm high. Apart from these peaks the surface is smooth, with just a random network of small ridges. No pyramids occur at the outer edge of this surface, but here there are several more pronounced ridges, which are radially oriented. This picture indicates an air pressure normal to the center of the surface and an outward air flow near the edge. From this can be concluded that this surface of the meteorite must have been either the front or the rear side during the flight. Structures on the adjacent sides indicate that it was, in fact, the front.

The three small surfaces carry many ridges, all lying approximately perpendicular to the front face. These ridges are about 0.1 mm high and a few mm long. They look like runnels of melted wax on the side of a candle. Some droplets have solidified on the way backwards and the ends of the ridges are invariably occupied by a droplet (see Fig. 3). Amalgamation of two ridges to give a V-form with a globule at the tip is not uncommon. With the aid of these droplets it is easy to determine the direction of movement of the air stream over this surface.

Slightly off centre on the rear side of the meteorite, some small sharp regmaglypts occur. Melt ridges of the same type as those on the side radiate out from this area, but they stop short at about 5 mm from the edge,

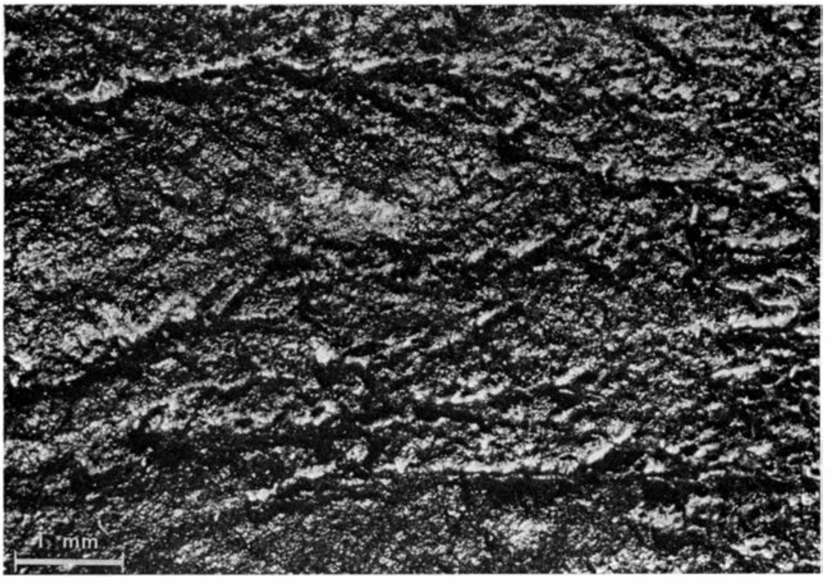

Fig. 3. Melting ridges with globules on the rear surface.

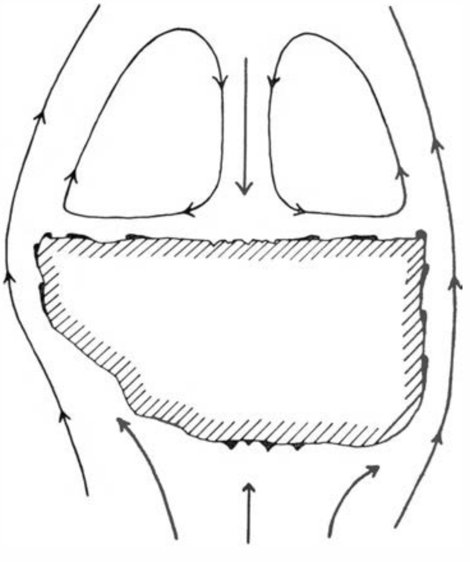

Fig. 4. Schematic air motion around the meteorite. Fusion crust structures exaggerated.

in a coky border zone. The droplets on these ridges show that the air flowed from the central part towards the edges. In between the ridges the surface is smooth. In many places the ridges are quite even and carry no droplets. The structure of the rear fusion crust indicates a turbulent air motion of the type shown schematically in Fig. 4.

Fig. 5. Spattering on the rear surface of the Trysil meteorite.

The phenomenon of spattering has also been observed on the Trysil meteorite. At some places on the rear edge the fusion crust is overhanging against the rear surface. At these points spattered material has been deposited as elongated drops or chains of drops (see Fig. 5). The spattered material is black and has a high lustre. It is easy to establish that it has been swept away from the overhanging edge and has settled on a solidified rear fusion crust. This spattering is commonly confined to a 5 mm wide zone around the edge, but small single drops of spattered material have also been found well into the central parts of the rear surface. These small drops have their thickest part away from the edge which demonstrates that they did not take part in the turbulent movement.

It must be concluded that the two types of melted material found on the rear surface have developed at different times. This could be taken as support for the theory that the rear surface is an original surface of the meteorite. But, as emphasized above, the ridges and the thickness of the fusion crust exclude that possibility. Another explanation is that the temperature on the sides was higher than on the rear surface. Therefore in the last stage of the flight, the crust on the rear surface was solid while the material on the sides was still molten.

None of the other Norwegian meteorites belonging to the Mineralogical-Geological Museum in Oslo (Ski, Tysnes, Mjellum, Morradal and Otteröy) show external structures of this type on the fusion crust.

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