The Elgygytgyn Crater Glasses

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The Elgygytgyn impact structure is a 3.5 Ma old crater situated in the mountainous central part of the Chukotka Peninsula, Russia. The crater is expressed by a circular depression 18 km in diameter surrounded by an uplifted original rim. The deepest part of the depression is occupied by the Elgygytgyn lake 12 km in diameter and to 170 m deep. R. Dietz supposed that the Elgygytgyn is the biggest modern impact site on the Earth's surface and that it was a source crater for the Australasian tektites. This idea was refuted when the age of the crater was determined.

The glassy bombs, impact melt rocks and shock metamorphosed rocks occur in redeposited sites in the lakustrine terraces inside the crater and rarely are they spread in the terraces of the little creeks around the crater rim.

The glassy bombs have drop-like, cake-like, cylindrical and irregular form (Fig.1). The bombs size ranges from 1-2 cm up to 15 cm in diameter and the weight varies from 5-10 g up to 2000 g. Fluidal textures are visible on the polished shears of some bombs and in thin sections of the glass (Fig.2). The bombs are black, rarely dark gray, their surface is dull. The glass has a bright luster on fresh breaks. Rare inclusions are white to colorless transparent lechatelierite and white shock metamorphosed quartz. The gas bubbles in the glass are up to 5 mm in diameter and have a shiny surface.

Deep open cracks are the main peculiarity of the bomb surface. The cracks form from one to three systems that differ in their depth. The formation of cracks happened due to the solidification of the bombs' surface during their transportation in the atmosphere. The depth of the cracks depends on the thickness of the glass crust on the surface of the melt core, thus the earliest cracks are from 1 to 2 mm deep and the latest ones reach up to 5-7 mm deep, and about 5 mm wide on the surface of bombs about 6-12 cm in diameter. All cracks have U-like, rarely V-like cross-sections. The tracks of viscous tension of the melt are visible on the bottom of some cracks (Fig.3).

It is supposed that the volume of the open cracks corresponds to the

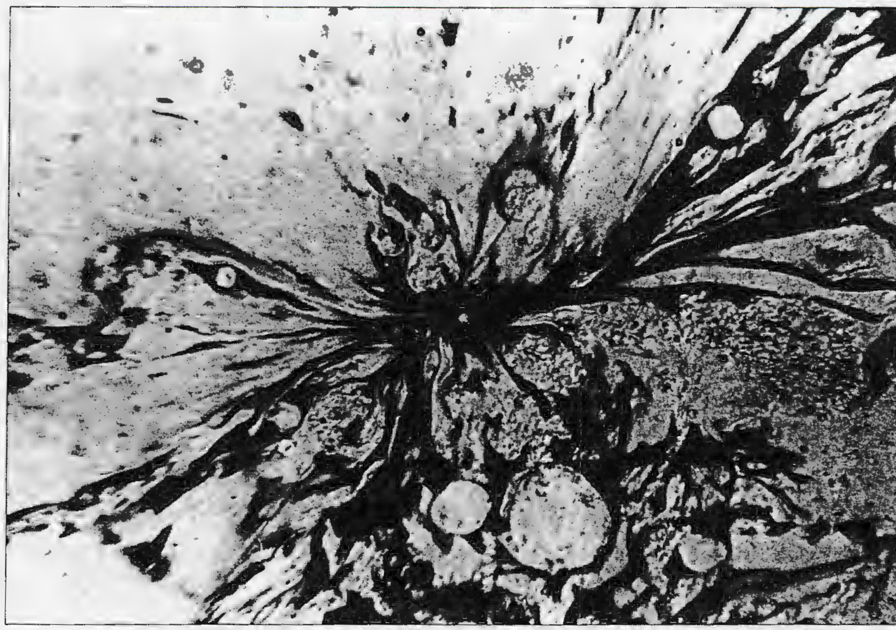
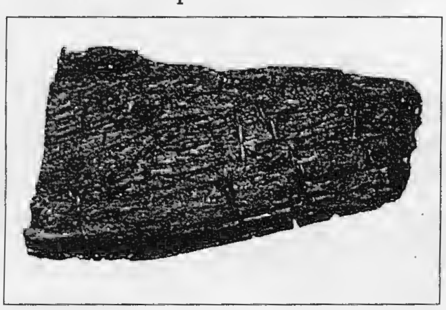
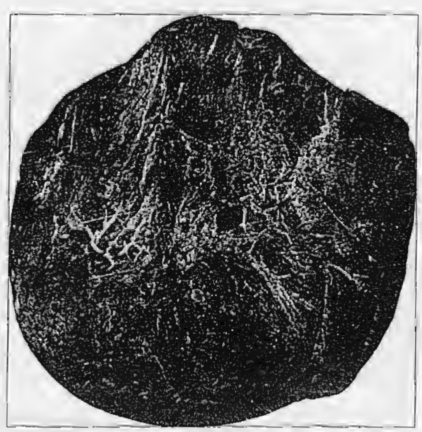


Fig. 2. Thin section of inhomogeneous glass. Plane polarized light, 90X.



(a)

(b)



(c)

Fig. 1. Shape of the bombs: a) prolongated bomb with deep transversal cracks; b) a quarter of the diskous bomb; the concentric cracks are supposed to be a track of the impact of the bomb surface by a little particle in the ejecta cloud. All images are 0.7 of the bombs natural size.

Fig. 3. The strips of the melt stretching on the bottom of a crack, 20X.

Fig. 4a. Striated relief on the lateral surface of the bomb (20X).

melt volume decreasing from the onset of solidification to the end of the process. The volume of the cracks of 25 bombs measured, varies from 0.5% to 3.7% of the whole volume of each bomb. The bombs with crack volume from 1.0% to 1.5% have maximal propagation. The estimation of temperature decrease from the onset of glassy crust formation to complete solidification of the bombs was made using the volume of the cracks and the coefficient for volumetric expansion for silicate glass (about 3.0×10^{-6}/°C). The contraction of about 1.0-1.5% corresponds to a temperature drop to about 400 °C. A temperature interval of about 1200 °C corresponds to the bombs volume decrease of 3.7%.

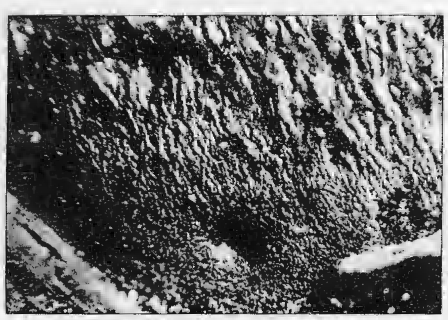


Fig. 4b. A region of surface protected from ablation by a positive surface form (20X).

Tracks of ablation and secondary melting are visible on the surface of eight bombs. All these bombs have drop-like form and size from 4.0x5.0x6.9 cm to 7.3x10.5x11.0 cm. The ablation tracks are expressed by the striated relief on the lateral surface of the bombs (Fig.4-a). Bubbles stripped by ablation up to 3 mm in diameter appear on the surface of these bombs. Tracks of secondary melting occur on the walls of some open cracks. Positive forms of the bomb surface relief protect some plots of surface from ablation (Fig.4-b). The maximal thickness of ablation and secondary melting approaches up to about 1.5 mm. The experiments carried out by D.R. Chaprnan have shown that the thickness of ablation of tektite glass up to 2 mm conforms to an entrance velocity into the atmosphere of about 5 km/sec.

We suppose the following history of glassy bombs' formation:

1) ejection of melt drops and particles from the crater;

2) formation of aerodynamically shaped forms of bombs;

3) solidification of bombs crust during flight along upward and downward trajectories;

4) ablation and secondary melting of bombs surface by entrance into atmosphere on the downward trajectory;

5) fall of solidified bombs on the Earth's surface. Absence of rock particles carved into the bombs surface is evidence of their fall in solidified state or with solidified crust.

The form of the Elgygytgyn bombs and properties of their glass are similar to the properties of some tektites. The density and refractive indices of the Elgygytgyn glass are very close to the density and refractive indices of indochinites and philippinites. Chemical composition of the bombs is close to the composition of these tektites, but the main difference is the higher content of alkalies in bomb glasses.

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