with increasing latitude. The autumn minimum seems to be appearing again despite resumption of Soviet testing in August and September 1962.

The remaining feature of interest in Fig. 1 is the southward drift into the southern hemisphere of debris from U.S. nuclear testing, which was resumed at Christmas Island (2°N, 157°W) on 25 April 1962. There is no clear evidence from Fig. 1 that any debris from this source appeared in surface air at any of the northern hemisphere stations. However, radiochemical analysis will no doubt show that at least *some* debris entered the northern hemisphere. A complete accounting of the distribution will require consideration of synoptic meteorological observations made at and shortly after the time of detonation. The appearance of larger concentrations at Chacaltaya than at Lima could result from altitude differences or from passage south of Lima of the main concentration before it passed through the 80th meridian.

Junge (*5*) and others have calculated "exchange rates" between the northern and southern hemisphere by assuming that the rate of transport from one hemisphere to the other is given by a constant of proportionality times the difference of tracer content between the hemispheres. The contrast in Fig. 1 between United States and Russian debris transports shows that interhemispheric transport depends crucially on where within the hemisphere debris is concentrated.

Some debris was injected into the troposphere from low yield devices detonated in July 1962 in Nevada. However, either because the atmospheric yield was small or because the plumes, starting a relatively short distance upwind, passed between the stations of the 80th meridian, this debris makes no obvious appearance.

Many of the uncertainties of interpretation may originate from variations of concentration with longitude, particularly shortly after detonations a short distance westward from the 80th meridian. Additional insight may be gained by analysis of activities of individual radioisotopes and activity ratios in a latitude-time section. However, these are at present available only as averages at bimonthly intervals (*9*). Sampling along an additional meridian would be very desirable (*10*).

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Maskelynite: Formation by Explosive Shock

Abstract. *When high pressure (250 to 300 kilobars) was applied suddenly (shock-loading) to gabbro, the plagioclase was transformed to a noncrystalline phase (maskelynite) by a solid-state reaction at a low temperature, while the proxene remained crystalline. The shock-loaded gabbro resembles meteorites of the shergottite class; this suggests that the latter formed as a result of shock. The shock-loading of gabbro at 600 to 800 kilobars raised the temperature above the melting range of the plagioclase.*

Maskelynite, an amorphous form of plagioclase, was discovered by Tschermak (*1*) as a major constituent of the Shergotty meteorite which fell in India in 1865. This meteorite is a basaltic achondrite, similar in composition and texture to many terrestrial gabbros. The major phases are maskelynite, of labradorite composition, and pyroxenes, which are mostly pigeonitic. Although maskelynite appears to be a clear isotropic glass, the grains have the rectangular outlines commonly shown by plagioclase crystals in gabbros; they also have straight cracks corresponding to feldspar cleavages. In contrast, the pyroxenes exhibit normal petrographic properties. Shergotty and one similar meteorite, which fell at Padvarninkai, Lithuania, in 1929, are the only representatives of the shergottite class.

The unusual characteristics of shergottite could be explained if maskelynite had formed from plagioclase by a solid-solid transformation rather than by ordinary fusion. Such transformations have been reported for quartz and other silicates as a result of a very intense neutron flux (*2*) and as a result of explosively generated shocks (shock-loading) (*3*). We now report the experimental production of a rock similar to shergottite by shock-loading of an ordinary gabbro.

Gabbro from the Stillwater complex in Montana was chosen since it is similar in texture and mineralogy to shergottite. The specimen was composed of plagioclase of about An_{80} composition and a lamellar orthopyroxene of the Bushveld type (*4*), in which the narrow exsolved lamellae are presumably diopsidic pyroxene.

Two wafers, 17 mm in diameter by 2 mm thick, were placed in a steel container, separated by an attenuator. The container, protected against spalling by momentum traps, was impacted by a steel flying plate (1.25 mm thick) that had been explosively accelerated to a velocity of approximately 4.5 km/sec (*5*). The container was unbroken, although somewhat deformed by the shock. Fairly large coherent fragments of both wafers were recovered and cut into thin sections. Peak pressures and temperatures during shock in these specimens were estimated by a graphical method with the aid of the Hughes-McQueen equation of state for gabbro and available handbook tabulations of thermodynamic data for gabbro at low pressures (*6*).

Peak pressure in the upper, more strongly shocked, specimen is estimated to have been in the range of 600 to 800 kb. For this specimen a temperature during shock of 1700° to 2100°C was calculated, which fell adiabatically to 1300° to 1700°C immediately after shock. For the lower specimen a peak pressure in the range of 250 to 350 kb was estimated. The maximum temperature during shock was calculated to have been 200° to 300°C, which fell adiabatically to 200° to 250°C immediately after the shock. On the basis of previous calorimetric calibrations of the experimental system, it can be estimated that post-shock heating of the lower specimen by conduction from the hotter portions of the container resulted in a final temperature of no more than 350°C.

In the lower specimen, which was shocked to 250 to 350 kb, the plagioclase was entirely transformed to maskelynite similar to that in the Shergotty meteorite. Examination in thin section shows grain outlines and cleavage cracks that are pseudomorphous after those of the original plagioclase (Fig. 1). The cracks and lines of inclusions

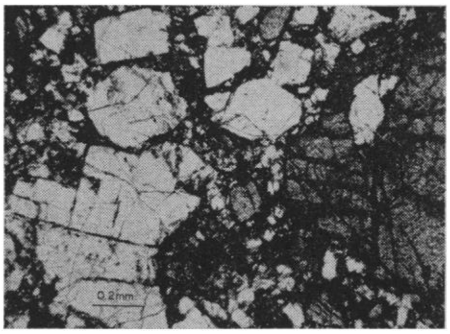

Fig. 1. Gabbro shock-loaded to 250 to 350 kb. Light grains at left are maskelynite; darker grain at right is pyroxene; between is a finely divided mixture of both phases.

are mostly straight; only rarely do they have a curvature indicative of deformation. These cleavage cracks are somewhat less abundant than those in the unshocked gabbro, but additional cleavage cracks may have developed in the feldspar of the unshocked material during the thin-section preparation. When measured 5 months after the experiment, the refractive index of the glass was 1.562, a value intermediate between the mean refractive index of about 1.573 for the crystalline plagioclase and the index of about 1.557 that would be shown by a glass of this composition fused at atmospheric pressure.

The pyroxene in this lower specimen appears crystalline, although the grains show the undulatory extinction and disoriented domains characteristic of severely crushed solids. In contrast with Shergotty, which shows no gross evidence of deformation, the shocked gabbro has a mortar structure with finely divided pyroxene and maskelynite between the larger grains. This structure is not surprising, in view of the observed deformation of the container. Furthermore, some of the damage undoubtedly resulted from the interactions of the reflected shocks originating at the poorly matched steel-gabbro interface. Similar brecciated structures occur in some basaltic achondrites, other than shergottites, and have been attributed to shock (*7*).

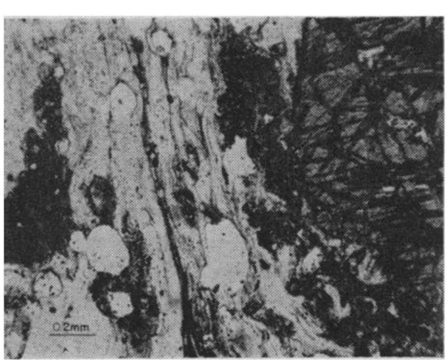

Fig. 2. Gabbro shock-loaded to 600 to 800 kb. Dark material is pyroxene; light material is plagioclase glass. Rounded white areas are vesicles.

The upper specimen, which was shocked to 600 to 800 kb, has a strikingly different appearance. The plagioclase has also been transformed to glass, but the glass contains swirled trains of vesicles extending through the thin section (Fig. 2). The refractive index of this glass varies in a range of about 1.560 to 1.562, which is slightly lower than that of the glass in the lower wafer. Some spherulitic aggregates of crystals have formed in this glass. It seems clear that the plagioclase was heated above its normal melting range. The orthopyroxene remained crystalline, with unchanged optic characteristics. This specimen also contained a grain of augite with a subsidiary phase in lamellae parallel to {100}, presumably orthopyroxene (*4*). The augite is unchanged, but the subsidiary phase has been transformed into glass. Apparent injection of this phase into fractures suggests that it was in a fluid state. The difference of behavior of this phase and the major orthopyroxene phase may be a result of a difference in composition or in the physical characteristics of the local environment during shock. The petrographic evidence on the whole indicates an after-shock temperature of about 1500°C, which is in good agreement with our calculation of 1300° to 1700°C.

The similarity of the lower wafer to specimens of the Shergotty meteorite strongly suggests that meteoritic maskelynite formed as a result of strong shock. The experimental reproduction of other features of meteorites, such as polycrystalline diamonds (*8*) and the veins in chondrites (*9*), by shock-loading lends support to this hypothesis.

The absence of features of physical deformation and the coherence itself suggest that the fragment represented by the Shergotty meteorite was in the interior of a larger object at the time of the shock that produced the maskelynite. Only a single 11-pound object, merely broken in two on impact, was recovered at Shergotty, which points to a time previous to entry into the earth's atmosphere for the occurrence of shock.

The name "maskelynite" has sometimes been loosely used for any glassy (or cryptocrystalline) substance of more or less feldspathic composition in meteorites. We suggest that the name would be more useful if it were restricted to material resembling the type maskelynite—that is, a noncrystalline phase that in a pseudomorphous way preserves the external features of crystalline feldspar (*10*).

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Phosphorescence of Rat Kidneys Cooled in Liquid Nitrogen

Abstract. *Cut surfaces of rat kidneys exhibit intense, reproducible, and very detailed phosphorescent patterns after they are cooled with liquid nitrogen and then exposed to shortwave ultraviolet radiation. Ligation of the renal blood vessels for a period of 6 to 24 hours destroys most of this phosphorescence, whereas a ligation of the ureter has no effect on kidney phosphorescence.*

Dental enamel undergoes a change, concomitant with certain pathological conditions, in capacity to exhibit afterglow when exposed at low temperature to shortwave ultraviolet radiation (*1*). We have now studied other organs, and have observed that kidney tissue shows phosphorescence at low temperatures.

Organs were removed and washed in an isotonic saline solution; they were then sectioned with a sharp blade