LASER ILLUMINATION OBSERVATIONS

A low intensity gas laser beam[2] was used as a convenient light source for illuminating small slabs or single crystals from various rock specimens. The crystals were immersed in oil and viewed under a microscope at right angles to the laser beam. The light reflected from the surfaces and the relatively few internal interfaces of ordinary undeformed crystals made them readily visible. However, highly shocked crystals, with their numerous internal interfaces, were invisible in a scintillating glow.

Furthermore, a beam impinging on a slab penetrated and illuminated an appreciable volume (approximately 1 cm^3) of unshocked, coarse-grained rocks and smaller volumes of fine-grained limestones. Highly-shocked rocks, notably Coconino sandstone from Meteor Crater, Arizona, contained and reflected the laser light within a hemisphere whose diameter was not much larger than that of the beam. These observations are consistent with the x-ray diffraction findings and may have bearing on a better understanding of the reflective properties of the lunar surface.

CONCLUSIONS

The x-ray and optical methods described, coupled with graphical representation of the data, are effective aids in revealing an impact history in any polycrystalline aggregate. These results are intimately related to internal fracturing of crystals on a submicroscopic scale, which is a dominant process in response to strong shock pressures and even to similar high pressures applied at the relatively slow rate of 5 kb/minute.

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[2] Bausch and Lomb instrument; He–Ne continuous beam; 1 milliwatt rated power; 6328 A.

REFERENCES

Bailey, S. W., R. A. Bell, and C. J. Peng, Plastic deformation of quartz in nature, *Bull. Geol. Soc. Am., 69,* 1443–1466, 1958.

Chao, E. C. T., J. J. Fahey, J. Littler, and D. J. Milton, Stishovite, SiO_2 a very high pressure new mineral from Meteor Crater, Arizona, *J. Geophys. Res., 67,* 419–421, 1962.

Chao, E. C. T., E. M. Shoemaker, and B. M. Madsen, First natural occurrence of coesite, *Science, 132,* 220–222, 1960.

Dachille, F., Interactions of the earth with very large meteorites, *Bull. S.C. Acad. Sci., 24,* 1–19, 1962.

Dachille, F., J. Fauth, and V. Vand, Mechanical deformation of shocked quartz grains as determined by optic axis measurements (Abs.) *Geol. Soc. Am. Spec. Paper 82,* 39–40, 1964.

Dachille, F., E. P. Meagher, and V. Vand, Shock-induced polymorphism or alteration in minerals (Abs.), *Geol. Soc. Am. Spec. Paper 82,* 40, 1964.

Dachille, F., and R. Roy, Effectiveness of shearing stresses in accelerating solid phase reactions at low temperatures and high pressures, *J. Geol., 72,* 243–247, 1964.

Dachille, F., R. J. Zeto, and R. Roy, Coesite and stishovite: stepwise reversal transformations, *Science, 140,* 991–993, 1963.

Dawson, T. H., and M. F. Rose, X-ray diffraction studies on nickel after shock loading, *U.S. Naval Weapons Laboratory Report No. 1889,* 7 p., 1963.

Freeberg, Jacquelyn H., Terrestrial impact structures—a bibliography, *U.S. Geol. Surv. Bull. 1220,* 91 p., 1966.

Gigl, P., and F. Dachille, Effects of pressure and temperature on the reversal transitions of stishovite. (Abs.), *Meteoritics, 3,* 111–112, 1967.

Guinier, A., *X-Ray Crystallographic Technology,* London, Hilger and Watts Ltd., 330 p. 1952.

Myers, M. B., F. Dachille, and R. Roy, Pressure multiplication effects in opposed-anvil configurations, *Rev. Sci. Instr., 34,* 401–402, 1963.

O'Connell, Edna, A catalog of meteorite craters and related features with a guide to the literature, Rand Corporation, Santa Monica, Calif., Publication P-3087, 218 p., 1965.

Short, N. M., A comparison of features characteristic of nuclear explosion craters and astroblemes, *Ann. N.Y. Acad. Sci., 123,* 573–616, 1965.

Short, N. M., Effects of shock pressures from a nuclear explosion on mechanical and optical properties of granodiorite, *J. Geophys. Res., 71,* 1195–1215, 1966.

Skinner, Brian J., and J. J. Fahey, Observations on the inversion of stishovite to silica glass, *J. Geophys. Res., 68,* 5595–5604, 1963.