

silica with smaller amounts of alumina, iron oxide, potash, and titanium oxide. That the alteration in the biotite caused by the radio-activity is very considerable follows from the fact that, as shown by Dr. Brammell of the Imperial College, the pleochroic spheres persist even when the biotite has been converted by pneumatolytic agencies into a substance practically identical with muscovite. He also found that it was necessary to keep biotite at a dull red heat for about six hours to render the 'haloes' invisible. During that time a very large amount of heat might be released without "catastrophic results."

Recently, records have been published of a deep boring at Dubbeldevlei in the Cape Province of South Africa (about Lat. 30° 30' S. and Long. 21° 35' E.), and they deserve consideration in connexion with this question. It reached a depth of approximately 5080 feet, and a survey by Prof. G. A. Watermeyer (*Trans. Geol. Soc. S. Africa*, vol. 26, pp. 65-7, 1924) showed that the depth could not be in error more than 0.3 of a foot. Temperature measurements were made by L. J. Krige and H. Pirow with the greatest care (*ib.* pp. 50-64). Down to 2137 feet the rocks consisted of horizontal Ecca and Dwyka beds, shales, with occasional dolerite sills, and tillite. Then came 550 feet referred to the Fish River Series, correlated with pre-Cambrian Pretoria Series. The remainder of the boring was in the ancient granites and gneiss which outcrop about fifty miles to the northward. They are widely extended in South Africa, not only at the surface but also below ground, as evidenced by fragments in the Kimberlite pipes (Du Toit, "Geology of South Africa," p. 44, 1926). They probably underlie all sediments except the primitive metamorphic rocks of pre-Witwatersrand age, into which they appear to be intrusive, and extend downwards for a depth of several miles at least. Being of acid composition they are presumably rich in radio-active substances. They must contain, too, a considerable amount of potassium, which Dr. Lawson claims as being radio-active.

The average temperature gradient for the whole depth of the boring was 1° C. in 31 m., but varied from 1° in 18.3 m. to 1° in 51.8 m., mainly in accordance with the conductivity of the local rock. In the granite and gneiss, the conductivity of which lies between 0.005 and 0.006, the average gradient was 1° in 45.4 m. In shale the gradient was at its highest, 1° in 18.3 m., for the conductivity of shale is stated to be only 0.0023. In the Witwatersrand mines the gradient is so low as 1° C. in 112.8 m., the conductivity of vein-quartz and quartzite being 0.0095, and that of pure quartz more than twice as much.

It is remarkable that the presence of extensive granite and gneiss in the lower 2400 feet of the bore, and for a far greater depth below, seems to have had no appreciable effect on the gradient. Unfortunately, no determination of the radio-activity of the rocks traversed appears to have been made. It is to be hoped that this will be carried out, as the cores are apparently still available. JOHN W. EVANS.

#### 'Seizure' with Sliding Surfaces.

In his letter to NATURE on "The Polishing of Surfaces" (Feb. 19) Mr. N. K. Adam refers to Hardy's work on static friction, showing the tearing away of surface particles of glass when one glass surface slides over another glass surface. In a leading article, *Engineering* (Jan. 23, 1925) emphasises the difficulty in understanding how forces of cohesion, exerted through surface layers, can ever be great enough to overcome the forces of cohesion between a particle of glass on the surface and the particles of glass immediately below the surface, in order that a scratch may

result. The writer in *Engineering*, as an alternative explanation, has recourse to ideas with regard to friction which Prof. Muir tells me were described so long ago as 1776 by Oliver Goldsmith in his "Survey of Experimental Philosophy": "The little risings in one body stick themselves into the small cavities of the other in the same manner as the hairs of a brush run into the irregularities of the coat while it is brushing. If the bodies slide one over the other, the little risings of one body in some measure tear or are torn by the opposite depressions."

What appears to me as a better explanation of the phenomenon of 'seizure' is afforded by the suggestion I made with regard to the polishing of surfaces (NATURE, Sept. 4, 1926), namely, that actual fusion of the surfaces occurs. The temperature at the point of seizure (one of the many points of 'contact' between plane surfaces) rises so high that actual fusion of the glass occurs across the surface layers, with subsequent rupture. It is only at first sight that this hypothesis seems extravagant, but Mr. N. K. Adam's reference (in the letter referred to above) to the "small thermal conductivity of the material," and his comments with regard to points of contact, indicate that some further explanation of the manner in which the thermal agitation is set up is desirable.

Space demands brevity, but there should be little difficulty with regard to the points of contact. Even such a material as wash-leather cannot possibly adjust itself to molecular irregularities. With regard to the setting up of the molecular agitation, it may be helpful if I refer again to the analogy of originating sound vibrations. My attention has been directed to a calculation made many years ago (I do not know by whom) showing that the natural frequency of sound or elastic vibrations of a particle of molecular dimensions is a high temperature frequency. Thus frequency =  $\sqrt{E/\rho}/2l = \sqrt{10^{12}/10^{-8}} = 10^{14}$  per sec., and the frequency of the dominant wave length in black body radiation at a 'bright red temperature' is about  $10^{14}$  vibrations per sec.

In conclusion, I would comment on Mr. Adam's statement that "Clearly the random removal of particles . . . from one point of the surface to another, must result in forming an amorphous layer, if continued long enough," by remarking that the ends of a freshly fractured glass rod do not cohere when pressed into contact again, and I do not understand how small fragments of glass in the polishing process can form an amorphous layer, polished or otherwise, without the intense molecular agitation or increase in temperature which gets rid of the surface layers.

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#### On the Volatility of Borax.

IN a discussion of the standardisation of hydrochloric acid with different standard substances (*J. Amer. Chem. Soc.*, 70, 1772, 1926), I made the following remark: "After the substance [borax] had been dried at 200°, the crucible was placed in an electric oven at a temperature of 700-750°, until constant weight was attained. When afterwards it was heated at 800°, at which temperature the salt fuses, the weight did not change. We cannot confirm the statement of H. V. A. Briscoe, P. L. Robinson, and G. E. Stephenson (*J. Chem. Soc.*, 122, 150, 1925), who state that fused borax loses sodium oxide. Even after the substance had been heated for two hours at 800° the weight did not change."

Prof. Briscoe and P. L. Robinson (NATURE, 118,