theory (*7*), which proposes that the effects of a skin sensory input are determined, in part, by the balance of activity in large and small fibers. The brief period of vibration preceding tactile stimulation would tend to close the gate to the stimulus, thereby shortening its central effects (*7, 8*). Since the vibration produced an afterglow itself, there is the possibility that its effect was due simply to distraction. However, this is unlikely since the subjects reported that the tactile stimulation itself was perceived, after vibration, as being more (rather than less) distinct, and distraction by problem-solving tasks did not have a demonstrable effect on afterglow durations.

The intriguing report of a "zone of awareness" suggests that central control processes, such as attention (*7*), may facilitate central transmission of all inputs from a skin area. The pulsatile property of the experience reported by some subjects indicates that it may reflect, in part, input from blood vessels or surrounding tissue. Similarly, the mislabeling of the warm-probe (or cool cap) stimulation as stinging pinpricks may also be due to central effects on the input. It is possible that when insufficient or ambiguous cutaneous information is applied to the skin, the input undergoes maximal summation and is perceived as pain. Whatever the mechanisms, the results suggest that brief stimulation of the skin produces central neural activity that may continue as long as several minutes after cessation of stimulation, and that the sensory input is modulated on the basis of both sensory and central neural mechanisms.

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15 December 1967

Zircon Lead Loss: A Kinetic Model

Pidgeon, O'Neil, and Silver (*1*) reported the loss of up to 63 percent of its lead by a metamict Ceylon zircon subjected to a fluid pressure of 1000 bars at 500°C. In their experiments the rate of loss decreased rapidly during the first 10 hours and very slowly afterward. They suggested that the loss mechanism became inhibited by a second process, possibly related to recrystallization of the zircon. The lead isotopic ratio 206/207 remained constant throughout the removal process, indicating that hydrothermal leaching of zircons can produce discordant uranium-lead isotope relationships of the "episodic" type (*2*). It is thus of some interest to attempt to model the removal process and define parameters which can be tested for consistency.

The simplest model consistent with the results of Pidgeon *et al.* was found to be one in which the lead-loss process is instantaneously first-order with a variable rate constant reflecting in turn a first-order "annealing" process (the term "annealing" is used in order to avoid the implication that actual recrystallization must be a first-order process, since dimensional factors may be involved in the inhibitory mechanism). The overall loss process is then described by the two equations

$$d \ln f/dt = -k \quad (1)$$

$$d \ln (k-k^*)/dt = -a \quad (2)$$

where f is the fraction of the original lead still present in the crystal, k is the variable rate constant for the leaching process, k^*, is the "fully-annealed" limiting value of k, and a is the annealing-time constant. If the initial value of k is denoted by k_0, the fraction of original Pb left at any time is

$$\ln f = -k^*t - \frac{(k_0 - k^*)}{a} \times (1 - \exp[-at]) \quad (3)$$

The calculated curve for the data of Pidgeon *et al.* is shown in Fig. 1; deviations of the experimental values are in

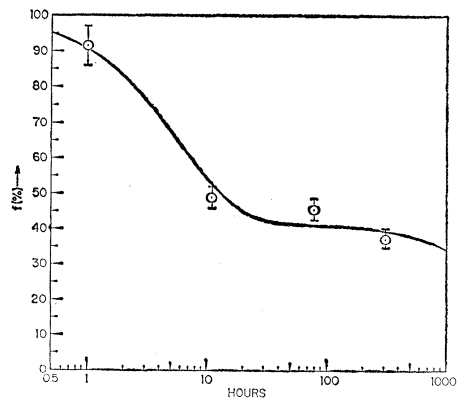

Fig. 1. Solid curve: fraction of original Pb remaining in zircon crystals plotted against time, calculated from Eq. 3; circles are experimental points from Pidgeon *et al.* (*1, 3*).

accord with their experimental errors of ±3 percent of lead concentration (*3*). Values of the constants used in Eq. 3 are $k_0 = 0.105$; $a = 0.12$; $k^* = 0.0002$.

The instantaneous rate constant k decreases by a factor of 500 in a relatively short time because of the exponential nature of the "annealing" process built into the model. The first-order dependence in Eq. 1 may be consistent with the very low lead concentration in the zircon and the fact that finely ground powder (−100 to +200 mesh) was used; bulk crystals might obey a different law because of volume effects. Equality of k values for the lead isotopes 206 and 207 is required by the experimental data, which show that the leaching process is nonselective, as assumed in the episodic model.

With three parameters it is relatively easy to fit the data from one experiment. The usefulness of such a model must therefore be based upon reasonable and consistent relations between the parameters, correlated with such variables as temperature and degree of crystal metamictization in more detailed experiments extending the interesting observations of Pidgeon *et al.*

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3. Experimental values plotted in Fig. 1 were calculated from the concentration data in Table 1 of Pidgeon *et al.* (*1*); they differ somewhat from the fractions used in the text and Fig. 1 of (*1*).

8 September 1967