promazine 30 minutes after parathion, and every 6 hours thereafter until five doses had been given. To a second series of groups of ten rats, chlorpromazine was administered every 3 hours until five doses had been given. The rate of administration of these drugs corresponded to the maximum dosage given to people in cases of extreme anxiety. A third series of groups of ten rats (controls) was given a single dose of parathion followed by 0.9 percent sodium chloride solution given every 6 hours. The results are shown in Table 1.

The LD_{50} values indicated that the treatment with promazine increased the toxicity of parathion by a factor of about two and chlorpromazine increased it by a smaller factor. The LD_{50} value of parathion in the control rats corresponds closely with the value of 13.0 mg/kg for technical parathion which was reported earlier (*8*). Administration of these drugs to parathion-poisoned rats did not alter the time of onset of symptoms or the time of death.

Male rats which were given a single dose of peanut oil alone followed by dosage with promazine or chlorpromazine, as in the first and second series, exhibited marked depression but recovered overnight after treatment was discontinued (Table 1). Single doses of promazine as large as 160 mg/kg produced severe depression, from which all of the rats recovered completely.

A single 5 mg/kg dose of promazine

Table 1. Effect of promazine (P) and chlorpromazine (CP) in male rats given repeated oral doses (3.0 mg/kg) of these compounds following a single oral dose of parathion. Promazine was given every 6 hours, chlorpromazine every 3 hours; controls were given 0.9 percent NaCl every 6 hours.

Parathion dose (mg/kg)	Mortality (No. dead/No. tested)		
	P	CP	Control
0.0	0/10	0/10	
3.0	0/10		
4.0	1/10		
5.0	7/10		0/10
6.0	5/10	2/10	
7.5		6/10	
8.0	9/10		0/10
9.0		8/10	
10.0	10/10		2/10
12.0		9/10	5/10
15.0			10/10
	LD_{50} (mg/kg)		
	5.4	7.3	12.0
	Confidence limits of LD_{50} (mg/kg)		
	4.7–6.3	5.7–9.4	10.5–13.7
	*Survival time (hr)**		
Range	1–95	2–69	1–69
Mean ± S.E.	15 ± 3.5	13 ± 2.6	14 ± 4.0

* For rats that died.

Table 2. Effect of promazine and atropine treatment in adult female rats given a single oral dose of parathion (3.6 mg/kg). Starting 30 minutes after parathion dosing, the atropine was given intraperitoneally every hour until ten doses were given and the promazine was given intraperitoneally every 3 hours until four doses were given.

Dose (mg/kg)		Onset of symptoms (hr)		Mortality (dead/tested)		Survival time (hr)	
Atropine	Promazine	Range	Mean	Test 1	Test 2	Range	Mean
0	3	1.50–2.25	1.17 ±0.115	4/4	4/4	1–22	11
2	3	1.50–8.25	3.09 ±0.79	2/4	4/4*	12–47	31
2	0	1.50–7.25	4.00 ±0.96	1/4	0/4	93	93
0	0	1.25–3.25	2.03 ±0.24	0/4	2/4	6–70	38
0	3†			0/4			

* Started treatment 30 minutes before parathion. † Peanut oil only in place of parathion.

potentiated the toxicity of 2.5 mg/kg of parathion which was given to groups of ten female rats within 30 minutes before to 1 hour after the administration of parathion. There was little effect when the promazine was given 4 hours after parathion.

Repeated dosage with promazine and atropine resulted in slightly higher mortality than atropine alone or no treatment following the same dose of parathion (Table 2). Tests with chlorpromazine gave similar results.

In all these tests, the rats that died exhibited typical symptoms of parathion poisoning.

Groups of ten female rats were each given a single oral dose of 5.0 mg/kg of promazine 30 minutes before, at the same time, and at two intervals after a single 3 mg/kg dose of Phosdrin. This dosage level of Phosdrin is slightly less than the oral LD_{50} value (3.7 mg/kg) for female rats (*8*). Promazine did not appear to have any effect upon the toxicity of Phosdrin. All of these rats exhibited typical symptoms of Phosdrin poisoning; either they died or showed a marked recovery within 2 to 3 hours. After this work was completed, we learned that Mitchell R. Zavon (*9*) had found that chlorpromazine, at dosages higher than those we had used for promazine, increased the mortality of rats previously dosed with Phosdrin (8 mg/kg). He noted the potentiation in each of three series of tests in which the rats were given repeated doses of atropine at the rate of 0, 1, and 2 mg/kg; when results of the atropine tests were combined, the mortality was 1, 7, and 15 out of groups of 15 rats which received repeated doses of chlorpromazine at the rate of 0, 5, and 10 mg/kg.

The results tentatively suggest that, in treatment of parathion or Phosdrin poisoning, tranquilizers derived from phenothiazine should either be avoided or at least used with extreme caution. We have not investigated the possibility that these drugs may increase the toxicity of other pesticides containing organic phosphorus.

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References

1. L. E. Hollister, *Ann. Internal Med.* **51**, 1032 (1959).
2. L. E. Hollister, *Calif. Med.* **89**, 1 (1958); L. Krawitz, *Vet. Med.* **52**, 442 (1957); W. C. Dolowy, I. D. Thompson, A. L. Hesse, *Proc. Animal Care Panel* **9**, 93 (1959).
3. J. D. Arterberry, R. W. Bonifaci, E. W. Nash, G. E. Quinby, *J. Am. Med. Assoc.*, in press.
4. G. Frada and G. Gucciardi, *Med. Lavoro* **49**, 81 (1958).
5. J. H. Wills, *J. Med. Pharm. Chem.* **3**, 353 (1961).
6. R. Dahlbom, H. Diamont, T. Edlund, T. Ekstrand, B. Holmstedt, *Acta Pharmacol. Toxicol.* **9**, 163 (1953).
7. J. J. Litchfield and F. Wilcoxon, *J. Pharmacol. Exptl. Therap.* **96**, 99 (1949).
8. T. B. Gaines, *Toxicol. Appl. Pharmacol.* **2**, 88 (1960).
9. M. R. Zavon, personal communication.

24 September 1962

Potassium-Argon Dating of Plutonic Bodies in Palmer Peninsula and Southern Chile

Abstract. From the determination of the potassium-argon age of three plutonic bodies late Cretaceous to Cretaceous-Tertiary boundary ages have been calculated.

Potassium-argon determinations for age have been made on unweathered surface samples of three plutonic bodies found in the northern part of Palmer (Antarctic) Peninsula and southern Chile (Table 1).

Argon (Ar) and potassium (K)

Table 1. Argon and potassium analyses from three plutonic bodies found in the northern Palmer Peninsula and southern Chile.

	Ar^{40*} (10^{-3} ppm)	Ar^{40*} / Total Ar^{40}	K (%)	K^{40} (ppm)
		Sample 1		
	4.7 ± 0.5	0.243	0.82	
	5.0 ± 0.3	0.307	0.87	
			0.97	
Av.	4.9 ± 0.3		0.89	1.09
		Sample 2		
	1.2 ± 0.2	0.100	0.131	
	0.9 ± 0.2	0.114	0.139	
Av.	1.0 ± 0.2		0.135	0.165
		Sample 3		
	17.5 ± 0.7	0.542	3.03	
	18.7 ± 0.6	0.616	3.25	
Av.	18.1 ± 0.7		3.14	3.83

analyses were made of samples of three plutonic bodies found in the northern Palmer Peninsula and southern Chile. Ar^{40*} refers to radiogenic Ar-40. Sample 1 (H-62-19) was obtained on Palmer Peninsula, latitude 63°25′S., longitude 58°03′W. A biotite concentrate, −40/+100 mesh, was separated from light gray granodiorite. The estimated composition of this concentrate is: 20 percent biotite, 80 percent chlorite, and a trace of feldspar and other minerals. The ratio Ar^{40*}/K^{40} is 0.0045 ± 0.0005, and the age of the sample is 75 (±8) × 10^6 years. Sample 2 (H-62-14), was also obtained on Palmer Peninsula, at latitude 63°17′S, and longitude 57°58′W. Dark green pyroxene (possibly augite, as determined by x-ray diffractometry), −40/+100 mesh, was separated from dark gray gabbro. The composition of this sample is more than 98 percent pyroxene. It has a trace of biotite and a trace of other minerals. The ratio Ar^{40*}/K^{40} is 0.0060 ±0.0012, from which the age was calculated to be 100 (±20) × 10^5 years. Sample 3 was obtained from Cascade Bay, in southern Chile, at latitude 53°57′35″S, longtitude 71°31′25″W. A biotite concentrate, −40/+100 mesh was separated from gray diorite. The estimated composition of the concentrate was 65 percent biotite, 35 percent of what might be amphibole, and a trace of other substances. The ratio Ar^{40*}/K^{40} was 0.0046 ± 0.0003. The age is calculated at 77 (±5) × 10^6 years.

In the analysis of the three samples, the constants used were:

$$\lambda_\beta = 4.74 \times 10^{-10}/\text{year}$$
$$\lambda_e = 0.585 \times 10^{-10}/\text{year}$$
$$K^{40}/K = 1.22 \times 10^{-4}\ \text{g/g}$$

$$\text{Age} = \frac{1}{\lambda_e + \lambda_\beta} \times \ln\left(\frac{\lambda_e + \lambda_\beta}{\lambda_e} \cdot \frac{Ar^{40*}}{K^{40}} + 1\right)$$

Petrographic examination of the Antarctic samples shows absence of crushing or straining of the minerals. This probably indicates that the plutonic bodies post-date the main tectonic disturbances.

Adie (*2*) assigned a late Cretaceous or early Tertiary age to the Antarctic Peninsula intrusive suite on the basis of petrologic and geochemical correlation with the intrusive suite of the Patagonian Andes. The potassium-argon ages provided in this paper substantiate Adie's designation of age, as far as the north end of the peninsula and the Cascade Bay region of southern Chile are concerned.

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References and Notes

1. The dating of the samples was carried out by Geochron Laboratories, Inc., Cambridge 39, Mass., and was financed through a grant from the National Science Foundation. This paper is contribution No. 82 of the Geophysical and Polar Research Center, University of Wisconsin.
2. R. J. Adie, "The Petrology of Graham Land," II. *The Andean Granite-Gabbro Intrusive Suite* (Falkland Islands Dependencies Survey Scientific Reports No. 12, 1955).

18 July 1962

Surface Textures of Sand Grains—an Application of Electron Microscopy: Glaciation

Abstract. To simulate glacial conditions, a mixture of ice and quartz grains was subjected to grinding under hydrostatic pressure of 500 bars. Electron microphotographs of these "synthetic" glaciated surfaces were then compared with electron microphotographs of grain surfaces which had been abraded and crushed by glacial action, and the correspondence was found to be good. Thus it appears possible to distinguish glacial sands from beach and eolian sands by examining the surface textures of these grains with the electron microscope.

During the process of transportation by glacial ice, sand grains may be subjected to considerable pressure and abrasion by the weight and movement of the overlying ice and sediment. This process may create surface textures which can be observed megascopically and which may also be observed microscopically with the electron microscope. Approximately 800 sections prepared from 75 samples from a number of known glacial outcrops were studied by means of the electron-microscopic techniques described in an earlier report (*1*). Quartz grains ranging between 0.5 and 1.5 mm in diameter were selected for the study. Polycrystalline grains were rejected to avoid complexity in interpretation. The surface textures of these natural grains were compared with those of synthetic grains to determine whether there were certain characteristic features which might be used in the identification of glacial environments.

A quartz plate slice was cut from the face of a Brazilian quartz crystal, and its surface was examined by electron microscopy; it proved to be essentially featureless. The plate was fastened on an Inconel piston which could be fitted into a stainless steel cylinder. A mixture of water and crushed Brazilian quartz weighing approximately 10 g, sieved to particle size of 8 to 10 mesh, was placed in the cylinder, the piston was inserted, and the entire device was frozen at −15°C. This device was then placed in a press and the contents were subjected to hydrostatic pressure of 500 bars. The piston was rotated at 5 revolutions per minute, and the experiment was continued for 5 minutes at constant pressure. Under the initial operating conditions of the experiment—temperature of −15°C and pressure of 500 bars—ice I was the stable phase. During rotation the temperature of the sample increased, due to frictional heat and the heat conducted from outside. The experiment was terminated at the first indication of melting, when friction suddenly decreased.

Pressure and duration of grinding in the glacial environment are extremely variable, and we therefore somewhat arbitrarily selected our values. The rotation at 5 rev/min for 5 minutes is equivalent to movement of 150 cm. Pressure of 500 bars may correspond to 5 km of pure ice at a density of 1, or 2.5 km of ice and rock debris at a density of 2.

Figure 1 is an electron microphotograph of the essentially featureless surface of a quartz plate before experimentation. Figures 2 and 3 show the results of our glacial experiments. The most prominent features are large conchoidal fractures which are characteristic arc-shaped sweeping steps. In addition, semiparallel irregular steps which may represent shear fracturing can be observed.

By comparison with grains from beach and eolian environment, these experimental grains have extremely high relief. Figure 4, a sand grain sampled from the Montauk till at Montauk