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10. We are aware of the great potential for error in estimating the number of persons at the zero value of the Poisson distribution [see L. Mantell, *Am. Doc.* **17**, 8 (January 1966)]. In addition to the logical error in the Mantell report (assuming authors publish in only one journal) subsequently discussed by H. A. Simon in a letter [*ibid.* **18**. 113 (April 1967)], substantial errors may result from obtained distributions differing from Poisson.
11. We thank Diana Crane for access to data from the manuscript of her unpublished book *Diffusion of Innovation in Science*. The obtained data for outsiders have been recast by supplying the proportion having zero contacts that would be predicted by a λ of 0.65.
12. The reader may question the choice of the Poisson as opposed to a variety of other distribution including Paretian distributions, the Whitworth distribution, and so forth. The data do not give a linear plot on log-log paper, which clearly eliminates hyperbolic functions. The data could be approximately fit by an exponential function or the Whitworth distribution; however, any negligible gain in goodness of fit would be offset by a necessary elaboration in assumptions.
13. The reader should be warned against interpreting persons whose contacts conform to the Poisson as being nonproductive scientists. The structure is being examined from the point of view of a single specialty and the outsiders were found by Crane (*11*) to include distinguished researchers in other fields. Further, one should bear in mind that a node of high communication does not always develop at the center of many specialties, a fact most clearly demonstrated in Griffith and Miller (*2*).
14. Supported by PHS research grant 1 R01 LM 00911.01. We thank D. Crane, N. C. Mullins, R. H. Orr, and D. J. de S. Price for comments on various drafts, and the last two, in particular, for directing us to recent related work on Bradford's law.

1 April 1971

Radio Echo Records Cannot Be Used as Evidence for Convection in the Antarctic Ice Sheet

In a report on convection in the Antarctic ice sheet (*1*), T. Hughes used some samples of radio echo records obtained in Antarctica in 1967 by a team from the Scott Polar Research Institute (SPRI), Cambridge, England, led by G. de Q. Robin (*2*) with logistic support through the U.S. National Science Foundation. They were presented as evidence for convection plumes in the Antarctic ice sheet.

It is misleading to publish radio echo records without a statement of some of the parameters of the system and an explanation of their effects on the film record. For instance, the radio echo system used by SPRI has a very broad beam fore and aft (in the line of flight) and a narrow beam from side to side; therefore, it is dangerous to interpret a strong echo on the film as a reflecting point at the appropriate range vertically below the observer. In fact, a point reflector gives a hyperbolic echo trace similar to the traces seen on the bottom of Hughes' figure 2 in the area of the Gamburtsev Mountains. The echo profile given by various shapes of surfaces and a method for computing the original reflecting surface from radio echo records are described by Harrison (*3*).

The radar system is carried in an aircraft at an altitude of about 1 km above the ice, so that the ray path through the ice can never be inclined to the normal to the ice-air interface at greater than the critical angle for refraction (34 degrees), and a specular reflection cannot be received from a surface whose slope within the ice is greater than 34 degrees. Furthermore, the rate of change of the total range of a specular reflector (whether there is refraction or not) can never be greater than the aircraft's velocity. Thus, the near-vertical lines seen in Hughes' figure 2 cannot be interpreted as vertical reflectors formed by either shear planes or convection plumes, and some alternative explanation must be given.

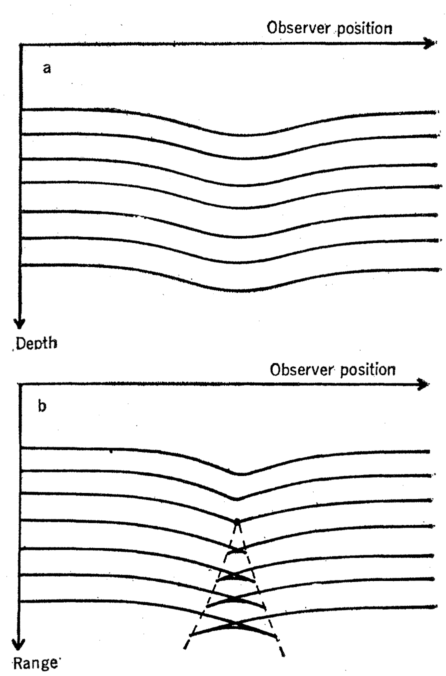

Fig. 1. (a) A number of partially reflecting layers arranged in a simple stack, and (b) echo range for the same layers plotted against observer position.

From an appraisal of all the Antarctic radio echo records at the SPRI, it has been found that the near-vertical patterns always appear in association with layers of large horizontal extent, some of which may be seen in Hughes' figure 2. The near-vertical patterns are explained by considering the geometry of specular reflections from a set of gently waving layers. In Fig. 1a, consider the set of partially reflecting layers and the observer to be within one medium of propagation. With Harrison's method (*3*) we can deduce the approximate range plots shown in Fig. 1b. Within the area enclosed by the broken lines there is the possibility of receiving three specular echoes from any one layer if the center of curvature of part of the reflecting surface lies below the observer's path. It can be shown that the echoes are generally strong above the triangular patch, since they arise from the concave surfaces; they are stronger still near the broken line, where cusps form, because here two echoes, each partially focused, are reinforcing one another; and they are strongest of all at the apex, where the three possible echoes are focused on the observer position. The shape of the patch of strong echoes depends on the shape of the layers and, particularly, on the way in which they are stacked one above another; it is further affected by refraction at the ice-air interface. It is also possible to take account of interference effects between two or more echoes in the triangular patch.

It must be pointed out that these features are not very common. In 1967 they were seen along only 700 km of flight line out of a total of 35,000 km. They occurred mainly near the Trans-Antarctic Mountains, the Gamburtsev Mountains, and a part of Marie Byrd Land where the terrain is rough. (The 2-minute section of film at Byrd Station in Hughes' figure 2, which shows a smooth bottom, is surrounded by evidence of rough bedrock, and the sloping tails of hyperbolic echoes from surface crevassing may be seen on the left.) Nearly all the records away from mountainous zones over thick ice sheet show unperturbed horizontal layers.

Although the instability of the Antarctic ice sheet suggested by Hughes may be theoretically possible, there is no evidence from radio echo sounding for near-vertical shear planes or convection plumes in the Antarctic ice sheet.

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31 December 1970; revised 22 March 1971

When I wrote my *Science* report (*1*), I relied on the tentative conclusion of Robin *et al.* (*2*) that the near-vertical reflections were "deep shear surfaces." When Harrison's paper (*3*) appeared, I wondered if those reflections might in fact be unreal. However, Bentley has evidence for anisotropy in the West Antarctic Ice Sheet, and he suspects that convection may be involved (*4*).

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14 May 1971

Oxygen-18 Studies of Recent Planktonic Foraminifera

Recently, Hecht and Savin (*1*) published results on variations of oxygen isotopes in shells of Recent planktonic Foraminifera. However, we contend that their results, in which various phenotypes with and without abnormal final chambers are compared, do not warrant the conclusions they draw, but are open to interpretations which are more compatible with recent field observations.

First, they have analyzed too few samples to be able to see any significant and consistent differences between the phenotypes. For example, one out of two samples showed a significant difference in ratios of O^{18} to O^{16} in pairs of phenotypes of *Globoquadrina dutertrei*. Significant differences were found in only one out of three samples for *G. cultrata*, three out of seven samples for *G. trilobus-sacculifer*, and one out of four samples for *G. conglobatus*. Only *G. ruber* phenotypes showed significant differences in all three samples. Thus, their results do not warrant the sweeping conclusion that diminutive final chambers develop as a response to environmental stress. It is curious that in the one instance where they did compare a sample consisting exclusively of saclike final chambers with whole shells of *G. sacculifer* (core G-1290) the isotopic difference is neglible.

With regard to *Sphaeroidinella dehiscens*, Hecht and Savin (*1*) concluded that it is not a late-stage encrusted phenotype of *G. sacculifer*, but that the two are distinct species. Here again, their interpretation is not warranted on the basis of their oxygen isotope results. Their conclusion depends largely on the purity of the so-called "outer-crust" of the last four chambers, which they regarded as 100 percent pure after having mechanically removed the spinose, inner chambers. In reality their outer crust is not homogeneous, but consists of a spinose "*sacculifer*" stage and a cortex ["calcite crust" of Bé and Hemleben (*2*)] of widely varying thickness (Fig. 1). Depending on its developmental stage, the translucent cortex can vary from less than 1 μm to about 40 μm in thickness (*2*). From Fig. 1 it is clear that it is impossible to separate mechanically the two intertwined units.

Our contention is that the reason why Hecht and Savin found so little difference in δO^{18} (*3*) between outer crust and whole tests of *S. dehiscens* is that the test wall of the last four chambers consists of late-stage secretion (our cortex) plus shell material secreted earlier (spinose *sacculifer* stage). The crucial factor determining the magnitude of δO^{18} difference is the ratio of cortex to *sacculifer* materials contained in the outer crust of *S. dehiscens*.

We have reinterpreted the values for *S. dehiscens* (core C-1), assuming different degrees of outer crust purity and using a value of δO^{18} of $+0.14$ per mil for the whole test, $+0.04$ per mil for measured outer crust, and -0.78 per mil for *G. sacculifer* (*G. trilobus* of Hecht and Savin). For example, if we assume that the outer crust is composed of 70 percent pure cortex and 30 percent *sacculifer* shell, then the calculated value of δO^{18} for the cortex would be $+0.39$ per mil. In this case, the total *S. dehiscens* composition would be 79 percent cortex and 21 percent *sacculifer* stage. Also the temperature at which this cortex would have been secreted would be about 5°C cooler than the temperature at which the *G. sacculifer* would have secreted its shell. This would indicate that the cortex is secreted onto the spinose *sacculifer* stage at greater depth in the water column. If we assume that the outer crust consists of 50 percent pure cortex and 50 percent *sacculifer* shell, we would get a calculated value

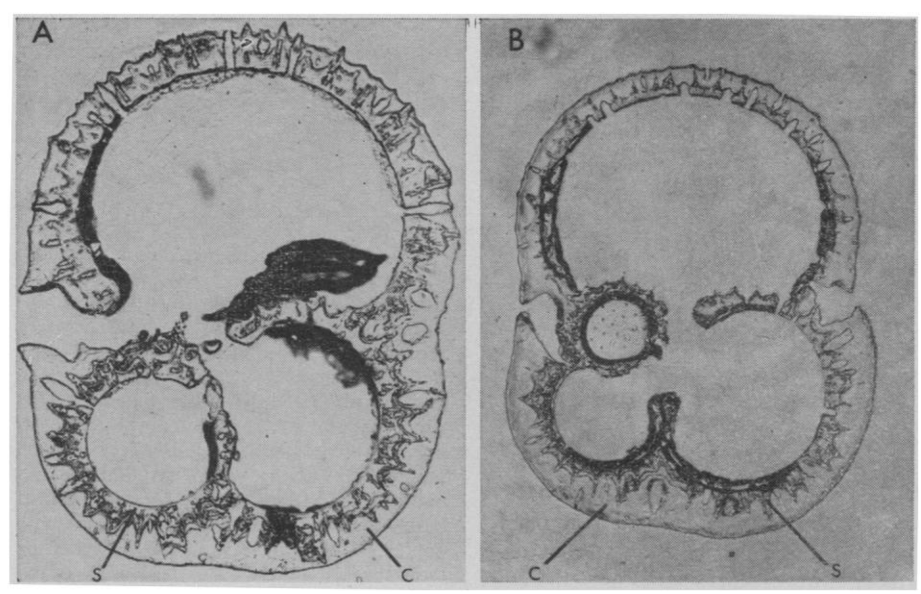

Fig. 1. Cross sections of *Sphaeroidinella dehiscens* (Parker and Jones) showing wall structure; *C*, cortex; *S*, spinose *sacculifer* stage. The cortex is thinner in (A) (× 116) than in (B) (× 94).