grazing can bring about such ground temperature differences, the regional climatic effects could be appreciable. Such mechanism of regional desertification would be in accordance with the approach to the dynamics of subsidence in desert climate developed by Charney (*8*). The global climatic effects of overgrazing might also be measurable.

The changes in the albedo of polar regions and the climatic consequences of these changes have been discussed by Flohn (*9*). He points out that the albedo of the polar sea ice lies between 0.62 to 0.80, whereas the typical albedo of the sea surface is between 0.04 and 0.10. Thus, the extension of sea ice, and also the extension of snow cover on land surfaces, are powerful climatogenic factors, which have global implications (*9*).

The possible variation in albedo in the case of snow or ice cover of polar regions versus clear sea and bare land areas of about 0.60 is higher by a factor of 5 than in the case of the baring of high-albedo soils, for which the computed difference of 0.12 is assumed to be representative. But the solar irradiation at the ground level is typically higher by a factor of 3 to 6 at the latitudes of the Deserts Belt than at the polar latitudes. The extent of some desertified areas, such as Sahel south of the Sahara, can be some 1.5×10^6 km^2, of the same order of magnitude as areas subject to changes in the snow or ice cover (2×10^6 km^2 in the Antarctic and 3×10^6 km^2 in the Arctic, as discussed by Flohn). Thus the global climatic effects of the baring of high-albedo soils can be comparable to the effects of variations in the snow or ice cover in the polar regions.

Vegetation recovers (rather quickly, as observed in some exclosures in the Sinai) when the pressures are removed. Thus, the hypothesized mechanism can be visualized as a cause of cyclical drought: if, because of drought, grazing animals die off or the population moves away in a nomadic migration, the vegetation recovers, the ground albedo decreases, surface temperatures increase, rains return to normal, and, with improved climatic conditions, population increases, which again puts anthropogenic pressures on the vegetation. The natural unit of time for such a cycle would be the age at litter-bearing of goats. As a gross oversimplification, it can be postulated that population explosion in grazing herds during "the seven fat years" is the cause of "the seven lean years."

There is an exact functional parallel between the mechanism of desertification presented here and the desertification mechanism ascribed to the dense pall of dust over the desert, raised by winds from the denuded surface. The dust, dwelling over the denuded areas, affects the radiative transfer, causing a diabatic cooling of the mid-troposphere and a resulting increased mean subsidence rate and increased aridity (*10*). The theory has been developed for the Rajasthan desert in India. Since dust is not a permanent blanket over most deserts, the dust theory does not seem applicable in general to the arid regions of the world.

In presenting here this climatic desertification mechanism, I have tacitly assumed that the basic wind pattern over the region is unchanged. The amounts of rainfall in the desert belt depend heavily on the gross circulation patterns which vary with shifts in position of the main anticyclones (*11*). The question of the extent to which changes in ground temperatures over large areas can bring about shifts in circulation patterns is not addressed here.

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Antarctic Glacial History from Analyses of Ice-Rafted Deposits in Marine Sediments: New Model and Initial Tests

Abstract. *Contrasts between the latitudinal distributions of ice-rafted debris deposited in deep-sea sediments during Pleistocene glacial and interglacial periods are predicted by a new model. The model requires the existence of a restricted zone where rates of deposition of ice-rafted debris are essentially independent of glacial-interglacial cycles. Initial tests and published results show that the concept is valid in the Southern Ocean and that it provides a new means of diagnosing major migrations of climatic zones.*

Deep-sea sedimentary cores are prolific recorders of Earth history, simultaneously providing evidence of past changes in climate, microfauna and flora, sea floor dynamic processes, geomagnetism, atmospheric particulate transport, and other phenomena. In high latitudes, marine sediments also include materials deposited by melting icebergs. Study of the spatial and temporal distribution of such ice-rafted debris (IRD) has long been recognized as a promising means of diagnosing the behavior of the polar ice caps (*1*). The advantage of the method over conventional land-based geological techniques is particularly obvious for Antarctica, where almost all relevant geological evidence (especially that for interglacial periods) remains inaccessible (*2*). Studies of deep-sea sedimentary cores have conclusively shown, for example, that Antarctica was a source of icebergs as early as the Eocene (*3, 4*), whereas similar results from studies on the continent are very difficult to obtain (*2*).

As stressed by Denton *et al.* (*2*), however, analyses of IRD have not provided any substantial advances in understanding the details of past fluctuations of the Antarctic ice cap, and it is the unraveling of this history which has maximum prospective significance. Most published results concerning IRD have simply equated observed increases in concentrations with increased iceberg activity, which is, in turn, almost invariably assumed to occur during glacial periods (*5–7*). In contrast, Denton *et al.* (*2*), Fillon (*8*), and Anderson (*9*) have warned that IRD maxima may, in some instances, be associated with interglacial periods. It is now well established that ice has been present on Antarctica throughout at least the Pleistocene (*6*), so that iceberg production has been continuous. Warnke (*10*) has summarized the factors that prevent simple interpretation of glacial deposits in deep-sea sediments, stressing the hypothesis that the debris available for incorporation into the parent glaciers may systematically diminish as subglacial erosion continues on the continent, to yield icebergs with little or no debris toward the end of an erosional cycle. Another important restriction is that ice shelves, presumably devoid of debris in most cases, are the source of the majority of icebergs (*2*). In several studies (*6*) between-core variations of IRD do not appear to be coherent, while in others (*11*) correlations of IRD have been made between cores. No consideration has hitherto been given to the possibility of diachronism in IRD horizons.

In Fig. 1 we present a simple model that not only reconciles previous conflicts in the interpretation of occurrences of IRD, but also clarifies the full potential value of IRD studies in selected regions.

Figure 1a is designed to present the following ideas with particular reference to the Southern Hemisphere. Interglacial periods, when the 0°C isotherm is in its southernmost latitudes, are marked by minimal ice-shelf extent, and more frequent calving of icebergs from the coastal glaciers can be expected; this creates an accumulation rate of IRD which is high close to the continent but decreases rapidly northward away from the source. During glacial periods, however, ice shelves will assist in creating a relatively barren zone close to the coasts. The more northerly position of the 0°C isotherm will result in a more northerly zone of melting and deposition. The relative amounts of IRD released during glacials and interglacials will be reflected in the areas under the two curves in Fig. 1a: This will depend on durations, intensities, and rates of onset and retreat of the respective periods.

The relevance of the model to studies of the Pleistocene IRD record in deep-sea sedimentary cores is illustrated in Fig. 1b, which is derived from Fig. 1a, but expanded into a time-dependent series under the assumption of oscillating glacial and interglacial periods: the four hypothetical curves are thus equivalent to the records which sediment cores could ideally be expected to provide for the relative latitudes indicated. Three main points emerge from inspection of Fig. 1b: (i) the amplitude of the IRD signal will vary systematically and simply with latitude, but the variation between cores could appear to be complex if glacial and interglacial periods are not independently defined. (ii) The IRD maxima and minima will be diachronous. (iii) In the latitudes where the two curves intersect in Fig. 1a there must be a region where the IRD accumulation rate is essentially independent of the timing of glacial and interglacial periods. We call this the glacial debris conjugate region (GDCR). Here there will be minimal correlation between IRD accumulation rates and paleotemperatures, in contrast to expected strong positive and strong inverse correlation south and north of the GDCR, respectively.

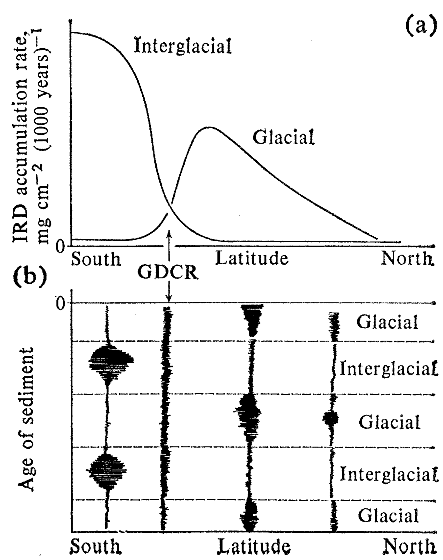

Fig. 1. Model explaining the spatial and temporal distribution of ice-rafted debris (IRD) in deep-sea sediments of the Southern Ocean during glacial and interglacial periods. (a) During interglacial periods, when the 0°C isotherm is at its southernmost position, the IRD accumulation rate is higher close to the continent (to the south) because of increased iceberg calving, and decreases rapidly northward. During glacial periods IRD deposition is minimized close to the continent by ice-shelf growth, but extends much farther northward, corresponding to the movement of the 0°C isotherm. (b) Adaptation of the model in (a) to predict IRD accumulation rates during alternating glacial and interglacial periods as a function of latitude in four sites. The IRD deposition maxima will be during interglacials in southernmost latitudes and during glacial periods in more northern latitudes. The glacial debris conjugate region (GDCR) is the zone where the two curves in (a) intersect, so that the glacial debris accumulation rate is essentially independent of glacial-interglacial cycles. The position of the GDCR would migrate substantially in time if the intensities and rates of initiation and termination of glacial periods were variable. See text for further discussion.

As a simple test of this model, we have examined the IRD and paleotemperature record for the Brunhes to Matuyama epoch in five sedimentary cores collected by the R.V. *Eltanin* from the southeastern Indian Ocean (Fig. 2a). The cores were selected because of their coherent paleomagnetic signatures and known sedimentation rates. The coarse fractions (> 62 μm) are siliceous and calcareous planktonic microfossils, IRD, and minor amounts of manganese micronodules and volcanic glass shards. Siliceous components become subordinate in the lower latitudes. The IRD is subangular to subrounded quartz and feldspar grains, and rock fragments. Samples of volume 8 cm^3 were taken from all cores at intervals of 5 to 10 cm. Conventional sedimentological methods were used to separate the fraction in the size range 62 to 250 μm, which we believe provides the optimum IRD signal. The percentage of IRD was obtained from 300-grain counts with transmitting and binocular microscopes. The criterion for diagnosing IRD is well established (*12*). An apparent accumulation rate, in milligrams per square centimeter per 1000 years, is then derived by using the volume, average density, and paleomagnetically and micropaleontologically determined sedimentation rates.

The most practical paleoclimatic index available is the percentage variation of the cold water radiolarian *Antarctissa strelkovi*, which Keany (*13*) has shown to be closely related to paleoclimatic variations identified by using planktonic foraminifera (*14*). Earlier, Petrushevskaya (*15*) showed that the surface sediment distribution of *Antarctissa strelkovi* in the sub-Antarctic corresponds closely to the observed sea surface distribution. Slides of the fraction >62 μm were prepared by conventional microfaunal methods, and entire slide populations, ranging from 300 to 1000 specimens, were counted for all samples. The results for three of the five cores examined are illustrated in Fig. 2, b to d. Core E48-03 proved to be almost totally devoid of IRD, indicating the general absence of melting coastal icebergs in the area around latitude 40°S for the past 0.3 million years.

The paleoclimatic curves for the three cores do not correlate with those for equatorial and North Atlantic regions (*16, 17*). Ruddiman (*17*) mentioned that Pleistocene Antarctic sea temperatures seem to have been either out of phase or independent of those of the Northern Hemisphere and equatorial oceans. Differences in the paleoclimatic curves of E50-12 and E49-24 are due to a disconformity at the top of the latter, so that the upper 0.4 million years is absent.

The data for core E50-12 (Fig. 2b) exhibit a clear and consistent positive correlation between warmer waters (or interglacial periods) and increased IRD accumulation rates, as required by the segment of our model (Fig. 1) poleward of the GDCR. Exactly the same relationship has been observed throughout core E49-30 (Fig. 2a).

In core E49-24 (Fig. 2c) relatively large and frequent changes in IRD accumulation rates have been detected, but there is no correlation with the inferred temperature changes. We suspect that this core may be in the GDCR, and because of its close proximity to the present Antarctic Convergence (Fig. 2a) we believe that the positions of the Antarctic Convergence and the GDCR may be intimately related, particularly since iceberg occurrences could be expected to diminish north of the Convergence. Support for this proposal can be found in similar data for site 278 of the Deep-Sea Drilling Project (*18*), located on the present Antarctic Convergence in the Emerald Basin at latitude 56°33.4′S. The number of glacial quartz grains per sample shows virtually no relation to the percentage of *Antarctissa strelkovi* throughout 65 m of core, except in limited instances where an inverse correlation is present: This could be explained by occasional southward migration of the GDCR or Antarctic Convergence, with the site at other times being mostly in the GDCR. Core E49-24 (Fig. 2c) has much higher IRD accumulation rates than the cores to the south, conceivably because the core is in a region of rapid iceberg melting.

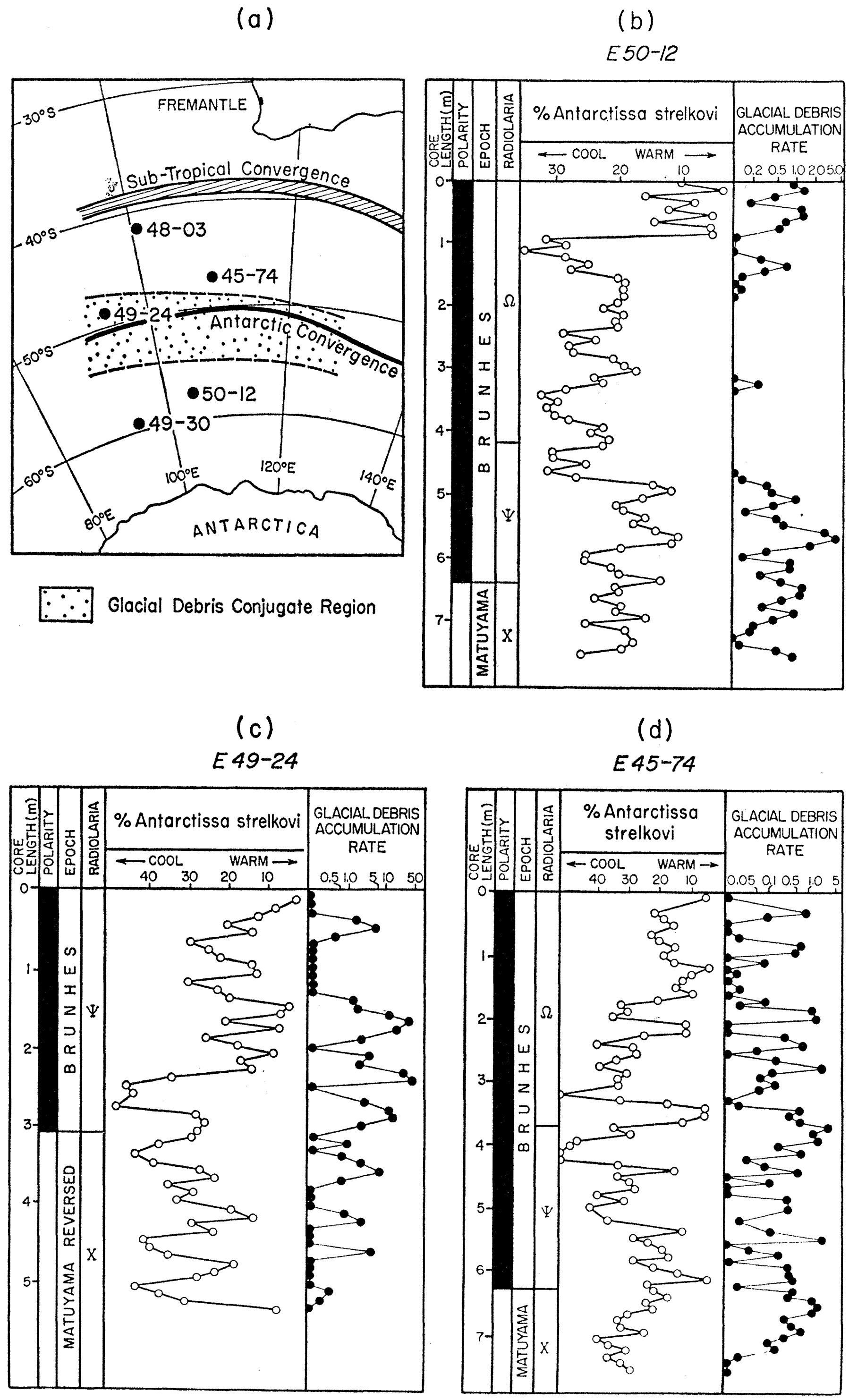

Fig. 2. (a) Map showing the locations of the five deep-sea sedimentary cores examined; the cores were obtained by the R.V. *Eltanin*. The exact core locations and water depths are: E49-30, 59°0.3′S, 95°13.8′E, 2339 fathoms (1 fathom ≈ 1.8 m); E50-12, 57°57.2′S, 105°01′E, 2407 fathoms; E49-24; 47°59.3′S, 95°02.2′E, 1757 fathoms; E45-74, 47°33.1′S, 114°26.4′E, 2080 fathoms; and E48-03, 41°01.2′S, 100°00.7′E, 2149 fathoms. The present positions of the Antarctic Convergence and Subtropical Convergence (*21*) are added. The approximate position of the possible glacial debris conjugate region (see Fig. 1) is added. (b to d) Glacial debris accumulation rates and paleoclimatic curves for three of the selected cores. The diagrams show core length, paleomagnetic stratigraphy, polarity epoch (*22*), radiolarian zones (*7, 23*), percentage of *Antarctissa strelkovi* (*13, 15*), and glacial debris accumulation rate for the fraction in the size range 62 to 250 μm (in milligrams per square centimeter per 1000 years).

which could be expected to result from the temperature rise at the Antarctic Convergence.

In core E45-74 (Fig. 2d) the IRD accumulation rate and the water temperature are positively correlated in most of the lower 500 cm. This segment of the core is therefore consistent with a location south of the GDCR, the approximate geographic limits of which are added to Fig. 2a. Similar strong positive correlations (between percentage of glacial quartz and inferred water temperature) have been documented by Margolis and Kennett (*4*) for two Pleistocene cores just north of the present Antarctic Convergence in the south-central Pacific. These occurrences, and their contrast with the data for E50-12 and E49-30, must be accepted as strong support for the major concepts involved in the model. The upper 300 cm of core E45-74 (Fig. 2d) exhibits a strong inverse relation between IRD and temperature, consistent with the core location being north of the GDCR. This requires the GDCR to have migrated southward at the time involved which, if constant sedimentation rates are assumed, is estimated paleomagnetically as about 0.33 million years ago.

In summary, we believe that our model (Fig. 1) may provide a means to more fully utilize the IRD signal recorded in all subpolar sediments, although we realize that it may be subject to modification (*19*). The limited tests we have applied and the earlier published data merely support the principles employed. Simple correlations between IRD maxima in deep-sea sediments (*11*) may not be valid unless the cores involved are all located on one side of the GDCR. Previously noted incoherence in correlations between cores (*6*) may be at least partially explained by the latitudinal range of the cores involved. It will be unrewarding to attempt to make paleoclimatic inferences from IRD abundance variations in cores spanning large latitude ranges. On the other hand, detailed and diverse analyses of closely spaced south-north traverses may yield definitive data on the timing, rate of change, extent, and intensity of the glacial and interglacial periods in the Southern Hemisphere (*20*).

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Anomeric Specificity of Glucose-Stimulated Insulin Release: Evidence for a Glucoreceptor?

Abstract. *The effects on insulin secretion of α and β anomers of* D-*glucose were studied in the in vitro perfused rat pancreas. Both phases of insulin release showed consistent stereospecificity for α-glucose; this specificity indicates an action of glucose independent of intracellular glucose metabolism.*

D-Glucose in solution or in the circulation is heterogeneous, consisting of approximately 64 and 36 percent of the β and α anomers, respectively (*1*). Nevertheless, the relative effectiveness of these naturally occurring anomers of D-glucose on secretion of insulin is unknown. The present studies, in which the perfused rat pancreas was used, show that regulation of insulin release has a stereospecificity favoring α-glucose. Since intracellular glucose metabolism may not be affected by glucose anomers (*2*), the observed stereospecificity suggests a glucose effect on insulin secretion localized at the cell membrane.

Specific details for perfusion of the rat pancreas in vitro and the immunoassay for rat insulin have been previously described (*3, 4*). In short, the pancreas, with adjacent stomach, spleen, and part of the duodenum, was removed from fasted rats. The preparation was placed in the perfusion apparatus, and perfusion medium consisting of 1 percent albumin–3 percent T-40 dextran in bicarbonate buffer (*p*H 7.4) was introduced into the celiac artery. Complete effluent was collected from the portal vein every minute after a single passage through the pancreas; flow rates were 10 ml/min. For the 5-minute pulse experiments, α, D(+)-glucose (anhydrous, Mallinckrodt) and β, D(+)-glucose (Sigma) were rapidly dissolved and introduced into the pancreatic preparation by way of a side-arm syringe. For longer perfusion experiments, the freshly prepared anomers were introduced from side-arm syringes kept at 4°C in an ice bath (*5*). The concentration of the α or β anomers in the the effluent was determined within 1 minute with the Beckman glucose analyzer. This system employs fungal