

collected upto a maximum depth of 4000 m at 17 oceanographic stations, were used to identify the regions of polar divergence, antarctic convergence and sub-tropical convergence. Within the limits of the available data, the polar divergence could be identified between 60° and 63° S. Antarctic convergence was observed slightly south of 52° S. Similarly, the boundary of the sub-tropical convergence was located at around 41° S. Downward gliding of the nutrient-rich water along the continental slope of Antarctica was also recorded.

The change in the oxidative ratios ΔAOU : ΔSi : ΔN : ΔP were 285:58:19:1 by atoms. A comparison of these with similar ratios from the Northern Indian Ocean indicated excesses of 19% nitrate and 45% silicate in the Southern Indian Ocean, while the phosphate concentrations in both these regions were found to be quite similar. Reserved fractions of phosphate and nitrate decreased significantly from the antarctic waters, south of the antarctic convergence, to the sub-antarctic waters found north of this region. This indicates that there is an increase in the intensity of oxidation from south to north. Similar values of reserved silicate in both the regions indicate their origin from oxidation and probably from other processes. Applying an empirical relationship between silicate and AOU, it was observed that the lower ranges of silicate concentrations were due to its consumption by siliceous algae, north of the polar divergence. Negative differences between the observed and calculated values of AOU suggest a transfer of oxygen from deeper to intermediate layers. Oxidative ratios do not indicate any difference in the rate of oxidation of organic matter in the Indian Ocean, north and south of the equator upto the zone of antarctic convergence.

Biological Investigations in Antarctica Ecosystems

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FIRST (1981-82) and the second (1982-83) Indian Scientific Expedition to Antarctica, gave an unique opportunity for biotic characterization of a multitude of ecosystems (Oasis; freshwater lakes; fast ice (icy sea shelf and 'Polynya') pack ice; open ocean and a number of subantarctic islands from a scientifically little known area, between 37° to 72° south latitude and 5° to 45° east longitude.

Deploying the trophic ecology energy flow approach attempts were made to study the composition, distribution, abundance and productivity potentials of different ecosystems and their contribu-

tion to Antarctic food web. Accordingly, floral and faunal components, in relevance to environmental oscillations, were explored.

Biotic components included bacteria, mosses, lichens, phytoplankton, zooplankton, benthos, krill, seabirds and marine mammals and the associated life process characterization, such as, chlorophyll and pheophytin pigment content; estimation of particulate organic carbon (POC); measurement of live carbon or adenosine tri-phosphate (ATP) and the rate of biological production and utilization at different trophic levels in the terrestrial, limnetic, glacial and marine ecosystem.

Some of the important findings were as follows:

- i. Under the tremendous biennial fluctuations in light intensity, lack of organic soil, and wind chill stress, the microflora, dominated by petrophilous lichen (*Acrospora* sp.) and moss (*Bryum* sp.), flourishes in the crevices and pores of rocks and boulders, in the Oasis ecosystem of Dakshin Gangotri (Antarctica).
- ii. Ice free exorheic lakes, forming a self-contained ecosystem, supported a high bacterial population ($12 \times 10^4 - 5.9 \times 10^6$ /ml), characterized by *Bacillus*, *Micrococcus* and *Corynebacterium*. Chlorophyll *a* content varying from 0.11 to 0.38 $\mu\text{g/l}$ supported a high rate of photosynthesis, ranging from 0.14 to 0.68 $\text{mgC/m}^3/\text{hr}$.
- iii. Fast ice (icy shelf and Polynya) and pack ice, constituting an independent but complex ecosystem, is dominated by unicellular algal organisms, distinctly different from the planktonic flora. While the plant pigment concentration was rather poor (0.027-0.067 $\mu\text{g/l}$), the primary productivity (0.24-0.48 $\text{mgC/m}^3/\text{hr}$) was reasonably high. Sea ice was poor in POC and ATP content. Highest surface chlorophyll value of 1.5 mg/m^3 and a production rate of 2.65 $\text{mgC/m}^3/\text{day}$, characterized the pack ice ecosystem.
- iv. Phytoplankton of the open sea environment, was contributed by 27 species of diatoms and 1 species each of dino and silicoflagellate, respectively. Average primary production rate of 3.72 $\text{mgC/m}^3/\text{day}$ in coastal waters was several times higher than that (0.95 $\text{mgC/m}^3/\text{day}$) in the off-shore areas. Bacterial counts and ATP content, displayed a direct relationship, with a significant part of POC, represented as detritus.
- v. The 68 species under 6 taxa, constituted the zooplankton. Standing crop, varied from 14 to 624 $\text{ml}/1000 \text{ m}^2$. Secondary production, exhibiting a distinct zonality, fluctuated between 8.4

- mgC/m³/day (coastal waters) and 249.8 mgC/m²/day (open sea). Light induced diurnal periodicity of vertical migration of zooplankton, was less pronounced, in the 'Polynya'.
- vi. Bottom fauna or benthos in the depth range of 200 to 3600m, was characterized by 12 meiofaunal and 3 macrofaunal taxa, with population density ranging from 118 to 29774, with a high mean count of 6760/m². Biomass production varying from 1.18 to 566.40 g/m². was exceptionally high at shallow depths and exponentially decreased with increasing depth and also away from the continent.
 - vii. High content of carbohydrates and organic carbon in the seafloor sediments, indicate the selective preservation of metabolites, during oxidation, under extreme low temperature regime.
 - viii. Observations on 13 species of seabirds and 5 species of marine mammals, reveal that the distribution and abundance is limited by such environmental parameters, as: sites for breeding and nesting, low temperatures, high winds (especially, for seabirds) and availability of food.
 - ix. Trophic relationship and energy flow in any Antarctic ecosystem, whether, oasis, limnetic, glacial or marine, is centered around the significant role of the key organism-Antarctic Krill-having uneven distribution with congregation of high standing crop, in the open sea and relative impoverishment in the coastal region.

Glass Transition: A Veritable Clue to the Nature of Glassy State

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SUPERCOOLED liquids congeal into an amorphous solid known as glass at the glass transition temperature, T_g . Glass transition is generally reversible. The transition of the glass to the supercooled liquid is characterized by rapid step-like rise of heat capacities and thermal expansivities in a manner reminiscent of a second order phase transformation in crystalline solids. A number of efforts¹ have been made to understand the nature of this transition but with no completely satisfactory explanation of the phenomenon. All such approaches to glass transition have assumed homogeneous disordered structure of glasses.

Glasses are x-ray amorphous and x-ray scattering techniques yield radial structure functions. The only

definitive information obtained from scattering techniques is local coordination numbers around the heavily scattering atoms in the glass. Use of other techniques like EXAFS has extended the structural information available to partial local structures around different types of atoms in a glass. Intelligent modelling has often provided more useful structural information. In recent times computer simulation has indicated interesting structural features such as presence of nonspace filling groups known as amorphous in glass forming systems².

Glasses are indeed microscopically homogeneous and isotropic. But structures in the submicroscopic range of the order of a few angstroms (20Å-100Å) do not seem to be homogeneous. Several experimental evidences, notably high resolution electron microscopy of ionic and metallic glasses, suggest strongly the presence of ordered regions of the dimensions of 20-100Å. Glasses are therefore heterogeneous over that scale of distances. Ordered regions in glasses appear to be held together by continuous matter whose structure is truly amorphous. It would therefore be more close to reality to consider glasses as microheterogeneous in which 'more ordered' regions which we call as 'clusters' are bonded by 'less ordered' regions which we call as 'connective tissue', ordered regions having typical dimensions of 20-100Å^{1,2}.

Glass transition models should therefore recognize the presence of such microheterogeneity. A qualitative difference would arise in treatment of glass transition phenomenon itself. If such a model of glass transition³ can explain known experimental facts with regard to various physical quantities and their variation through glass transition, it would serve to establish firmly that glasses are in general microheterogeneous⁴. Glass transition study could therefore serve as a clue to the nature of glassy state.

In the cluster model of glass transition^{3,6} more ordered clusters are conceived as bonded by less ordered tissue. Further, tissue is less dense and the particles in the tissue vibrate in highly anharmonic potential wells. Glass transition occurs when these clusters melt away into the tissue where particle motions characteristic of a fluid originate. In order to render mathematical treatment tractable, several simplifying, but reasonable, assumptions are made. More specifically, the features of the model are as follows. (a) Clusters are spherical and of equal size. (b) Particles in the tissue vibrate in anharmonic wells. As a result of the anharmonicity several potential wells are connected (coalesce) at thermally accessible energies. (c) Vibrational motion of particles excited into higher energy states of multiply connected potential regions gradually evolve into translational motion. (d) Particles on the surface of clusters which share the anhar-