

way, rather than on petrological similarities among similar tectonic features irrespective of location.

But in a paper which could well turn out to be one of the more important of recent years, Martin and Piwinski (*J. Geophys. Res.*, **77**, 4966; 1972) take, and develop, the point that Benson's definitions in terms of lateral pressures accord remarkably well with the concepts of the new global tectonics. Leaving aside transform faults, which have no associated magmatism and thus offer little scope for petrological correlation, modern lithospheric plates define two quite different tectonic settings—the convergent plate margin, where forces are predominantly compressional, and the divergent margin, which is largely tensional. These two settings, in turn, define orogenesis and the lack of it, for whereas regions of subduction are associated with orogenesis, tensional margins are unaccompanied by significant penetrative deformation and are thus essentially non-orogenic.

These ideas have led Martin and Piwinski to investigate the possibility that there may be significant petrochemical differences between orogenic-compressional-cordilleran zones and non-orogenic-tensional-laccormorphic zones. Such differences would be of interest in their own right; but, perhaps even more important, if they exist they could well help along the solution of other problems. For example, if correlations can be established for the relatively recent past, it may be possible to use them to distinguish tectonic settings relating to the period before the present drift episode—that is, beyond the past 200 million years or so. In view of the known difficulties in defining the plate patterns obtaining before the breakup of Laurasia and Gondwanaland, the potential of tectonic-petrochemical correlations is clear.

But do the necessary differences exist? Martin and Piwinski use data from four different igneous suites to show that not only do they exist, but at more than one level. The rocks in question were from the Aleutians (Alaska) and the Cascades (California, Oregon and Washington), representing emplacements along active oceanic-oceanic and oceanic-continental consuming plate margins, and from Ethiopia and Iceland, representing non-orogenic magmatism in both oceanic and continental environments.

Yet frequency plots for the four suites of the differentiation index (range 0 to 100) introduced by Thornton and Tuttle (*Amer. J. Sci.*, **258**, 664; 1960) clearly enabled the orogenic and non-orogenic rocks to be distinguished, irrespective of the geological environment. Thus both orogenic suites (Cascades, Aleutians) gave histograms single-peaked in the middle of the dif-

ferentiation index range (~35 to 65). By contrast, the non-orogenic Ethiopian and Icelandic suites produced bimodal distributions peaked at 20 to 30 and 80 to 90. As a result, Martin and Piwinski propound the view that bimodal distribution is typical of tensional regions irrespective of whether they are oceanic or continental. If this is really so, then it should be possible to use distributions of differentiation index to distinguish between orogenic and non-orogenic rock suites—and thus between compressional and tensional zones—even in pre-Wegenerian situations where other evidence of plate tectonic arrangements may not exist.

At a more subtle level, it may also be possible to make similar distinctions on the basis of detailed chemistry. If the percentage weight of a particular chemical constituent is plotted against the differentiation index, the trends in the variation diagrams are apparently similar for both orogenic and non-orogenic suites. But for some constituents the scatter of the data points is noticeably and significantly different. Thus for  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{Na}_2\text{O}$  and  $\text{K}_2\text{O}$ , in particular, the scatter for the non-orogenics is much greater than for the orogenics. It appears that  $\text{CaO}$  may also be a possible orogenic-non-orogenic discriminant in that the distributions within the AFM ternary diagram are quite different.

So far, the various methods of discrimination seem promising, although, as Martin and Piwinski point out, it would be wise to bear in mind that they may break down in specific instances. For one thing, a subduction zone may well be predominantly compressional but could easily have regions of local tension—for example, in the flexure zone where the lithosphere bends downwards. On the other hand, this sort of tensional region may rarely be magmatic (non-orogenic) because the open fractures may be limited to the upper part of the plate. But tension may also be characteristic of basins to the landward of oceanic trenches.

A second example is that of a lithospheric plate approaching a subduction zone, where the plate contains a spreading ridge. If such a ridge is still active it may well be non-orogenically magmatic even though it lies within the orogenically magmatic zone. Clearly in such a situation the two types of magmatism may be geographically and temporally confused. Yet another case is that of rock formed in a region of tension but subsequently remobilized in a region of compression. Ophiolite sequences, for example, may have been produced at ridge crests but then transported to, and remobilized in, subduction zones. Finally, there is, of course, always the problem of meta-

## Metal Ions and Nucleic Acids

A NUMBER of metal ions have been shown to have a crucial effect on the biological activity of nucleic acids. It is hardly surprising therefore that there is an increasing interest in the stereochemistry of nucleic acid-metal ion interactions. Most of the stereochemical information obtained so far has come from spectroscopic and X-ray single crystal diffraction studies of complexes of metal ions with bases, nucleosides and nucleotides. The folklore from the X-ray work is that the alkali metal ions and the alkaline earths tend to be coordinated predominantly to phosphate oxygens, sugar hydroxyls and water molecules in the crystal, whereas  $\text{Cu}$  (II),  $\text{Zn}$  (II) and  $\text{Hg}$  (II) tend to interact preferentially with the bases. Unfortunately the X-ray studies so far include only a relatively small number of structure determinations, and while spectroscopic studies have been more extensive they tend to be somewhat more equivocal. Nevertheless the spectroscopic work does indicate that metal ion binding to nucleic acids and their monomers may be considerably more complex than the X-ray studies suggest.

A communication by Berger, Tarien and Eichorn in next Wednesday's

*Nature New Biology* (October 25) is of particular interest in this connexion. It describes proton magnetic resonance and optical spectroscopic studies of the interaction of the copper (II) acetate dimer with various ribonucleosides and deoxyribonucleosides. An X-ray single crystal study of the copper acetate dimer alone had shown that the two copper atoms are separated by 2.64 Å—a distance which matches rather precisely the separation of the 2'OH and 3'OH groups of a ribonucleoside sugar.

By studying nucleosides with a variety of sugars (including the arabinose form where the two hydroxyls are on opposite sides of the sugar ring) Berger *et al.* are able to show rather conclusively that in addition to interaction with the heterocyclic bases of the nucleosides, the two copper atoms in the copper acetate dimer interact in a stereochemically specific way with the two hydroxyls of a ribose sugar. As Berger *et al.* point out the significance of this study does not lie in the biological activity, if any, of copper acetate, but in more general considerations of the basis for stereochemical specificity in polynucleotide interactions and particularly in those biochemical mechanisms influenced by metal ions.