beneath the South Portuguese terrane is distinct from that beneath the rest of Iberia which is generally composed of three layers totalling approximately 30 km in thickness.

The next day saw some elaboration of the characteristics of the Iberian terranes in terms of igneous, tectonothermal, stratigraphic and palaeontological data. Igneous papers dealt with the petrology, geometry and ages of plutons and their contact metamorphism and relationship to deformation. Tectonothermal evolution of terranes in the axial zone of the Pyrenees and in ophiolitic complexes in Iberia was expanded, and a comparison between the terranes in the South Portuguese Zone and southwest England was made. Stratigraphic analyses of the Late Precambrian and Early Paleozoic in the southwestern Spanish Meseta, central Ossa Morena terrane and in central Portugal were presented. Paleobiogeography of Late Cambrian trilobites, Ordovician faunas and Devonian-Carboniferous palynology of the South Portuguese Zone were applied to terrane analysis. The day ended with presentation of a model for the evolution of the Iberian terranes by E. Martinez-Garcia involving closing of the Hesperian Ocean beginning in the Early Ordovician, initial collision during Late Silurian-early Devonian followed by progressive convergence throughout Devonian and Carboniferous and ending in the Permian.

The next day was devoted to a survey of data relating to Paleozoic terranes in Europe, specifically the French Hercynides, Armorica, the Silurian-Polish Massif, the Eastern Alps, the Caledonides in Scotland, Eire, Anglesia, Poland, Scandinavia and the Alps. D. Matte presented a model for the Variscan Orogen in Western Europe involving the closure of two oceans: the Rheic and Galician-Massif Central oceans, between 420 and 500 Ma with initial collision occurring as early as 360 Ma ago. Migration of deformation, metamorphism and plutonism away from the sutures through time is a characteristic of the Variscan Orogen.

One day was devoted to the terranes in the Appalachian and Mauritanide-Rockelide Orogens. Appalachian papers dealt with various aspects of the terranes, such as the Grenvillian and Avalonian basements, sedimentology and accretionary history, plutonism and metamorphism. R.D. Dalmany and M. Villeneuve presented a comparison between an evolutionary model for the southern Mauritanides and southern Appalachians. The proposal recognizes three orogenic phases: (i) Pan-African I produced by the collision of a western block and the Western African craton yielding cooling ages of approximately 650 Ma, (ii) Pan-African II structures yielding approximately 560 Ma cooling ages, and (iii) Hercynian structures yielding approximately 280 Ma cooling ages. These are comparable to terranes and events recorded south of the Brunswick-Altamaha Magnetic Anomaly in the southern Appalachians. This session ended with a general paper by T.P. Trusdell on the sequence that terranes pass through during global tectonic megacycles.

The final day of the conference was devoted to map compilation workshops to define the legends for maps relevant to terrane analysis. These workshops were preceded by a lecture by J.D. Keppie on the methodology of producing metalloconic maps as one of the products of Project 233. The map workshops produced thematic map legends and the concept of time slice maps which could combine the various types of thematic data on individual maps. Projected map scale is 1:5,000,000 and the Decade of North American Geology Time Scale will be used. The first map will be a Preliminary Terrane Map of the Circum-Atlantic Paleozoic Orogens with the terranes classified as in the Circum-Pacific Terrane Map, and also showing overstep sequences and stitching plutons.

Two six-day field trips were run in association with the conference with the intent of critically evaluating the definition of the terranes in Iberia, and defining problems critical to their identification and accretionary history which could be tackled by co-operative research under the auspices of Project 233. The pre-conference field trip was led by E. Martinez-Garcia and J. I. Gil Ibaruchi, and involved a geotrail across the northern coast of Spain. The post-conference field trip involved a geotrail across the southern terranes in Spain from Toledo to Huelva, and was led by E. Martinez-Garcia, P. Herranz, M.A. de San Jose, A. Perejon, J. M. Gonzalez Casado, A. Piedra, O. Apalategui, L. Eguiluz and J.L. Hernandez Enrike. Two excellent guide books were prepared and the trips were very well run. A typical daily schedule involved a full day (08.30-19.00 hours) of field work followed by an evening workshop — intensive, but very stimulating! All participants learned a great deal about Iberian geology which would have been difficult any other way as most of the literature is in Spanish or Portuguese. As a result of the intense discussion throughout the two trips, a sharper definition of the terranes in Iberia will be available for the Preliminary Terrane Map of the Circum-Atlantic Paleozoic Orogens. Participants should also have a clearer idea of how to define terranes in their own parts of the orogens as a result of these working field trips.

A program with abstracts and a list of participants was published for the meeting. A volume of collected papers will be published.

Enrique Martinez-Garcia and his colleagues are to be congratulated on organizing such an excellent conference and field trips, and for publishing the first treatment of Iberian geology in terms of terranes in English.

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SLEADS (Salt Lakes, Evaporites, Aeolian Deposits) Workshop

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Although originally designed to focus on geological and environmental research in the Australian arid zones, the last two SLEADS conferences have included a much broader spectrum of international involvement (see Palaeogeography, Palaeoclimatology, Palaeoecology v. 5). This workshop, the fifth of its kind and held at Australian National University in Canberra 30-31 March 1987, saw papers presented by scientists from six nations, discussing regions from Saskatchewan to India, China, and, of course, Australia. Unfortunately, the collected papers from this conference will not be published except in the workshop abstracts (available from Patrick D De Cock, same address as above).

In his discussion of the late Pleistocene megalake paleohydrological problem, John Chappell demonstrated that if evaporation rates and groundwater regimes were held constant, then under steady state conditions, either rainfall or runoff must increase in order to fill the paleolakes to the levels that they occupied previously. Using conical lake geometry and a dynamic model with very rapid runoff followed by slow evaporation, however, the lakes could be maintained with only double the present rainfall. Chappell noted that to prove that the dynamic model applied would require more detailed survey and lake level fluctuation data. Unfortunately, the paper ignored groundwater effects and the potential differences in runoff as a function of vegetation changes, which elsewhere in Australia have had significant effects (Kershaw, pers. comm.).

Based on 7000 Australian Pleistocene dune orientations and 700 wind monitors, Bob Wasson et al. lucidly demonstrated that modern winds cross-cut dune field trends, especially near Perth and the Murray Delta. Late Holocene patterns do not match modern or 18 ka patterns. The modern wind
vortex centered near Lake Amadeus did not correlate with the 18 ka vortex in size or location. At 18 ka, they showed that the wind patterns were generally more zonal and stronger, the jetstream was unbroken, and the subtropical anticyclonic belt was further north, near its present winter position.

Since foraminifera diameters and species diversity fell inland, Rao et al., concluded that the marine forams found up to 800 km inland in the Thar Desert, India, were primarily derived from marine beaches or the continental shelf by eolian suspension of the low density tests. They felt sources such as the nearby modern foramin-bearing lakes, the Ranns of Kutch, and Tertiary molassic rocks were less important on the basis of the fauna collections. In the subsequent discussion, De Deckker suggested that Sr isotopes would solve the source problems. The conclusions of this paper were hampered by the lack of statistical population studies for the five potential sources and the dunes.

Several papers centered on discussions of the hydrology and sedimentology of salt lake regions.

At Spring Lake, Northern Territory, Gary Jacobson found that groundwater flowed under the dunes to rise in the playa bottoms. Although the dunes trapped freshwater lenses above older salt brines, recharge occurred only in the dune margins where the water table was less than 1 m deep. Drought produced gypsum flats and terraces, while playa capture has occurred as the systems age causing salt flat formation as the water table recedes.

As might be expected at the downstream end of the Wallandra Lakes system in the Prungle Lakes deep basin, John Magee found varve-like couplets of reversely graded gypsum crystals intercalated with normally graded detrital layers reflecting a sequence of flooding-drying cycles. Sediments were displaced by primary celestite (SrSO₄). Terriginous clays, biogenic carbonates, and organic-rich layers occurring nearshore flanked ridges composed of cross-bedded eolian gypsum nodules and clay pellets.

An enthusiastic Bill Last and L. Sleazak described a hypersaline meromictic lake, Firelight Lake, near Moosejaw, Saskatchewan, where they recognized at least six sedimentary-geochemical facies, ranging from a colluvial margin and exposed multimineralic carbonate-gypsum mudflats to a shallow water algal mat precipitating aragonite leading into the deep basin where debris fans of organic- and carbonate-rich sediments interfingered with mirabelleite (NaSO₄). The chemocline occurring at 5 m simultaneously with a temperature minimum was recognized by increases in H₂S, Na⁺, SO₄²⁻ and CO₃²⁻ concentrations. Sedimentation rates of 2 cm yr⁻¹ approximated those necessary to precipitate the 40 m of salt in the saline giants over 5 ka, according to the authors.

Patrick De Deckker and Bill Last discovered proteodolomite in both the bottom "yogurt" and as white films in lakes near Colac, Victoria. Fauna in the lakes reflected differences in clarity, hydrology, and chemistry, while the sediments in most contained at least 40% dolomite. With a Mg/ Ca ratio of at least 15, all the lakes were extremely poor in Ca²⁺ and SO₄²⁻ but were oversaturated with respect to dolomite, magnesite, hydromagnesite, monohydrate, and halite.

In West Basin Lake, Victoria, a saline meromictic lake containing an H₂S-rich glitziëia with dolomite, calcite, monohydratecalcite, and magnesite in the deep basin, Bill Last and Patrick De Deckker found active stromatolites. Nearshore penecontemporaneous cementation had produced boundstone magnesite pavements and beechrock, while in the vadose zone, hydromagnesite crystals had been pseudomorphed by dolomite. Generally, they felt the sediments became less endogenic with depth in cores.

For many years in Australia, a controversy regarding the source(s) of the salt in the salt lakes has raged. To many geochemists this seems astonishing. Until recently, reticent seawater remaining since the last transgression or aerosol salt were considered to be the only possible sources due to the similarity of the major element chemistry with that of modern ocean water. Contributions from connate waters or rock-water interactions were considered insignificant or even impossible. Several papers during the conference attacked this view.

In the Great Artesian Basin Jurassic and Cretaceous aquifers, Andy Herczeg et al. found that δ¹⁸O values increased with total salinity due to organic reductions producing CO₂. The 1.0 Ma discharge water had reduced Na⁺ and K⁺ concentrations due to reverse weathering reactions with clays that did not significantly affect the aquifer porosity, according to Herczeg.

Allan Chivas et al. found that brines from Lake Buchanan, Australia, could not be produced by mixing modern rain water with marine water. Using ⁸⁷Sr/⁸⁶Sr ratios, they proved that the brines most closely matched local rock rocks, while the ³⁴S/³²S ratios suggested that less than half the SO₄²⁻ resulted from aerosol sources, but the remainder derived from weathering Cretaceous rocks.

In Western Australia lakes, Barry Lyon et al. found pH values as low as 2.3 and extremely variable Fe concentrations which were not a function of Eh or Cl⁻, but were related to the local watershed rock type, further supporting the importance of water-rock reactions in brine salts derivation.

Since vadose wetting-drying reactions tend to greatly increase major element cation concentrations compared with salinity, while phreatic reactions reduce these back to seawater-like values, Lyons could account for all the variations seen in Australian lakes with these reactions. In the animated discussion following this paper, which continued long after the excellent Vietnamese smorgasbord dinner, the question of the vadose zone reactions could not be resolved to the protagonists satisfaction.

Several papers were devoted to the application of dating methods to the Quaternary deposits related to salt lakes.

In their ³⁹Cl dating method, Allan Chivas et al. used 12 MeV accelerated ions from Cs-irradiated AgCl sources counted in isobutane-filled heavy ion counters. Although ³⁹Cl/Cl only averages 10⁻¹⁵ to 10⁻¹⁴ naturally, the mid-century "bomb spike" in Australian dunes and Raleigh distillation effects were recognized. Australian brine ³⁶Cl/Cl ratios matched those of catchment sources rather than sea water. Since ³⁶Cl ages at Seaslake Lake compared "reasonably" with ¹⁴C, Th/U, and paleomagnetic ages, the authors are now determining the age of the 3 m Lake Nullabar salt speleothem.

In attempting to ¹⁴C date authigenic pedogenic carbonate from Cheng Jia Wu, China, John Head found few soil bacteria and plentiful low molecular weight polysaccharides in soil nodules laced with finely disseminated calcium carbonate. Although δ¹³C values were consistent at approximately -5.2% for all fractions, Head's acidic acid leach ages were consistently younger than HCl leach ages, yet both fractions resulted in identical ages regardless of depth down-section. A lack of thin section work and consistency tests within and along the soil horizons mar the conclusions regarding the method's usefulness.

In ²³⁰Th/²³⁴U dating pedogenic carbonates and gypsums of central Australia, Andy Herczeg corrected for detrital Th and U by calculating isotope ratios from both the acid leach and the insoluble residue fractions. Although Th/U ages were inconsistent for bones, some aragonitic mollusc shells compared with gastropod tests, ages for a few shells did agree with ¹⁴C ages. For the pedogenic carbonates, however, Herczeg's Th/U ages did not agree with thermoluminescence or ¹⁴C ages. The method probably failed because the author did not consider the possibility of open system U uptake or multiple sources for detrital U and Th.

Gary Jacobsen et al. reported that ESR ages for SpringLake gypsums and gypcrete gave consistent ages down-core, although they had not been tested against other dating methods. In this attempt, annual dose rates were back calculated by assuming ²³⁰Th/²³⁴U and ¹⁴C ages on an ESR "dated" pedogenic carbonate were correct. Since both Th/U and ¹⁴C are, at best, problematic, and at worst, incorrect, for dating pedogenic carbonates, the dose rate calculation and the consequent ages must be considered inadequate, until proper dose rates can be calculated by accepted methods, and the ages tested against proven methods.

Using induced magnetic field fingerprinting of magnetic minerals, Robin Clark and
F. Oldfield found that colour differences in the Streżeniecki dune field, Australia, were independent from the magnetic signatures which depended on location within the field and position within the dune.

In one of longest core from Australia, the 57 m Lake Terang core, Charlie Barton et al. determined that although the paleomagnetic O-ratio (intensity/susceptibility) paralleled the organic content curve, the former did not agree with median destructive field data regarding the magnetic mineral type and stability. Neither the Mungo nor Laschamp paleomagnetic inclination excursions were seen, nor was there any correlation with other Australian sequences, and dates were reported only for the upper portion of the core. Hence, no sedimentation rate could be estimated, although the authors claimed this core represents about 100,000 years of sedimentation.

Two papers to be presented by Chinese scholars were unfortunately not given due to inadequate translation facilities, although the authors were available to answer questions arising from the abstracts. Since such problems often hamper international conferences, it behooves organizers to consult speakers in advance to further unbiased scientific discussion.

Although the scientific calibre of the meeting was generally high, poor communication skills overshadowed several presentations. When will our profession learn that the obvious importance of the work cannot carry the burden in lieu of a well-organized, audible, concise, coherent argument illustrated with neat, well-labelled, legible, colourful diagrams? In interdisciplinary meetings such as this, moreover, it is often necessary to downplay the technical language and simplify the applications of the more peripheral techniques in order to maximize their impact.

By the end of the conference, it was obvious that arid region paleoenvironmental studies are severely limited by a dearth of proven dating methods. With the exception of 14C for fossils and charcoal and 36Cl for water or NaCl, the latter method still in its infancy, no methods have yet successfully dated either the typical mineral deposits or the fossils. Consequently, it is difficult, if not impossible, to estimate sedimentation rates and to time environmental changes, particularly beyond the range of 14C. If our knowledge of arid regions is to progress, it can be only hoped that the next few years will see the perfection and vindication of dating techniques for older fossils, pedogenic carbonates, and other minerals, and that methods can be developed that will span the 14C--KAr gap.

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