

their important contributions in this process to real problems.

I must confess that I do not go through posters extensively – I have a phobia perhaps. However, during my rounds in the poster sessions, I found that a few studies lacked proper motivation; in one or two cases the theoretical analysis of the experimental data was not very transparent. But this is in the nature of the wide spectrum of contributions that we do receive in symposia. Hopefully, the quality will improve and we shall see better work in the future

symposia. Obviously, I cannot comment on the content of specific posters because they are too many, and adequate time was not available to go through them in any depth. However, two posters which drew my attention were on (a) Nb/Al₂O₃/Nb Josephson-junction-based development of 1 V level voltage standard, which is at par with international level having an uncertainty of 1 in 10⁹ at NPL and (b) quaternary critical-point studies carried out at IISc.

The thesis 'Magnetic and 4f electronic quadruple anomalies in rare-earth

compounds', by Indranil Das (TIFR), was adjudged as the Best Presented Thesis by a panel of judges consisting of Drs P. S. Goyal (BARC), B. K. Srivastava (Jaipur), K. K. Bardhan (SINP) and V. P. S. Awana (TIFR).

The invited talks will be published as a special issue of the *Indian Journal of Pure and Applied Physics* as was done last year.

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The 1994 Goldschmidt Conference, Edinburgh

The fourth V. M. Goldschmidt Conference, an international conference for the advancement of geochemistry, held at Edinburgh (Scotland, UK) from 28 August to 2 September 1994 was a grand and mammoth event organized by the European Association of Geochemistry (EAG) and the Department of Geology and Geophysics, University of Edinburgh. The supporting institutions of the conference, among others, included the Geochemical Society, American Geophysical Union (AGU), Mineralogical Society of Great Britain and Ireland, Geological Society of America (GSA) and the International Association of Geochemistry and Cosmochemistry (IAGC). The unusual richness and enormous diversity of the conference symposium themes, coupled with exceptionally incisive and evocative expositions by researchers of repute, made the Goldschmidt Conference a stupendous scientific success.

The 15 major symposium themes, the total number of oral and poster presentations for each symposium, and the names of the conveners are listed below to highlight the current trends in modern geochemical research and the enviable popularity that some selected themes continue to enjoy: 1. Theoretical Geochemistry – 12 (G. D. Price & A. C. Lasaga); 2. Experimental Geochemistry – 60 (B. J. Wood & T. J. Falloon); 3. Geochemical Techniques and Applications – 4 (posters only); 4. Weathering and Erosion, Deposition and Diagenesis – 73 (M. Krom, R. Raiswell & J. I. Drever); 5. Groundwater Chemistry and Palaeohydrology – 26 (A. H. Bath & F. Philips); 6. Waste Containment and

Pollutant Transport – 26 (P. J. Hooker & A. C. M. Bourg); 7. Ocean Composition and Fluxes during the Quaternary – 19 (G. B. Shimmield & T. Pedersen); 8. Ocean Palaeochemistry and the Evolution of Ocean Basins – 20 (H. Elderfield, J. Veizer & M. Kastner); 9. Modern Submarine Hydrothermal Processes – 17 (H. Elderfield & S. Humphris); 10. Mechanisms of Isotopic and Chemical Communication in Crust and Mantle Rocks – 22 (C. M. Graham & D. R. Cole); 11. Partitioning of Elements – 26 (P. Beattie & J. Brenan); 12. Dehydration, Partial Melting and Fluid Distribution in the Crust – 44 (S. L. Harley, B. J. Hensen & M. J. Bickle); 13. Magma Generation Processes – 84 (R. Ellam, E. M. Stolper & D. H. Green); 14. Mantle Development in Space and Time – 68 (A. Halliday & A. W. Hofmann); 15. Geochronometry and Thermal History – 21 (R. A. Cliff, S. Inger & J. R. Wijbrans).

The scope of some of these symposium themes was so vast that each one of them was further divided into more than 4 subheadings. For example, theme 14 (68 presentations) was treated under 8 subheadings: (a) experimental constraints on melting in the mantle; (b) source regions, extraction and evolution of basaltic melts; (c) mantle mineralogy and the transition zone; (d) large-scale mantle to terrestrial geochemistry; (e) rare gases; (f) mantle fluids and mantle metasomatism; (g) small-scale evidence of geochemical processes in mantle rocks and ultrabasic complexes; and (h) mafic-ultramafic rocks and complexes. Some of these subheadings overlap with those of theme 13 (84 presentations)

The established conveners of all the themes quite expectedly brought in an air of academic authority and touch of class, and it was no surprise that their presence imparted scientific dignity to the scholarly proceedings.

One of the major attractions of the Conference was the four UK Mineralogical Society plenary lectures and one IAGC Ingerson lecture delivered by internationally renowned luminaries on wide-ranging topics. These few lectures took place at convenient times, when there were no other lectures in any sessions, so as to facilitate all the delegates to hear the distinguished masters. They are listed below:

Applying MeV ion beam techniques to geochemical issues: cross-fertilizing nuclear physics and geosciences (J.-C. Petit, Commissariat à l'Énergie Atomique, France)

The composition of the continental crust (K. H. Wedepohl, Gottingen University and Ingerson Distinguished Lecturer of IAGC)

Mantle plumes and other mail from the mantle (S. R. Hart, Woods Hole Oceanographic Institution)

Isotopic and elemental tracers in calcium carbonate fossils (E. A. Boyle, Massachusetts Institute of Technology)

Degassing history of the Earth (R. K. O'Nions, University of Cambridge and EAG President).

These lectures were not merely superb state-of-the-art reports by outstanding experts; they clearly provide insight into the future directions of research and give a glimpse of the emerging challenges in frontier areas. These brilliant expositions,

blended with subtle and subdued humour, have created an indelible impression on the minds of the audience.

The depth and breadth of the present-day geochemical research problems, together with the intricacies involved therein, were elegantly brought out with telling effect by an impressive array of keynote lectures. Without being invidious to the learned speakers, who are acknowledged authorities in their fields of specialization, all the keynote lectures are listed below to show the entire spectrum of topics: Evolution of the Earth's mantle: perspective from the Re-Os isotopic system (S. B. Shirey); Mantle stratification: constraints from mineral physics, seismological and phase equilibrium data (B. J. Wood & G. Helffrich); Rare gases systematics and mantle structure (C. J. Allègre & T. Staudacher); Experimental definition of mantle melting and implications for mantle dynamics (D. H. Green); Melting behaviour of mantle peridotites and compositional variations of partial melts at high pressures (I. Kushiro); Melting of mantle peridotite at pressures approaching the spinel-to-garnet transitions (R. J. Kinzler); The composition of high-pressure mantle melts: results from diamond aggregate experiments (M. B. Baker & E. M. Stolper); Connectivity of volatile-rich melts in mantle source regions: constraints from Fe-transport experiments (W. G. Minarik & J. M. Brenan); Basic magmas vary by eight orders of magnitude in oxygen fugacity: is this range required for their mantle source region? (I. Carmichael); Melt movement in the mantle (D. McKenzie); Causes of melt generation in the subcontinental mantle (C. J. Hawkesworth & others); Melt generation in the continental crust: answered and unanswered questions (A. E. Patiño Douce); Perspectives on shallow mantle melting from thermodynamic calculations (M. Hirschmann & others); The origin of typical NMORB: the evidence from a melt inclusions study (A. Sobolev & N. Shimizu); Focused flow of melt in the upper mantle: extraction of MORB beneath oceanic spreading ridges (P. B. Kelemen & others); Constraints on the MORB melting regime based on the Lu-Hf and Sm-Nd systematics (V. J. M. Salters & others); Batholithic, K-rich silicic magmatism in east-central Asia: evidence for a mantle source for progressive regional crustal potassium enrichment (S. M. Wickham & others); Partitioning and solubility of

PGEs in oxides and silicates (C. J. Capobianco & M. J. Drake); Experimental $cp\chi$ and garnet/melt partitioning of RFE and other trace elements at high pressures: petrogenetic implications (K. T. M. Johnson); The compositional dependence of HfSE partitioning: a comparison between pyroxene- and magnetite-melt systematics (R. L. Nielsen & others); What determines the values of mineral/melt partition coefficients? (P. Beattie); Geochronology and metamorphism (K. Mezger); Anomalous old Ar-Ar ages in high-pressure metamorphic terrains (S. P. Kelley & others); Stable isotope evidence for Earth's raw materials (R. N. Clayton & M. Humayun); Contrasting styles of oxygen isotope exchange (J. W. Valley & others); Global change of carbon isotopic composition of the biosphere during the Cenozoic (E. M. Galimov); Isotopic and geochemical evidence for old groundwaters in a granite on the Canadian shield (M. Gascoyne); A chromatographic model for water quality variations in the Aquia aquifer (Maryland, USA) (C. A. G. Appelo); Role of strong ligands for the infiltration of trace metals into groundwater (L. Sigg & others); Vegetative enhancement of chemical weathering (M. F. Cochran & R. A. Berner); An integrated model for feldspar dissolution under acid conditions (S. L. Brantley & L. Stillings); A new sedimentary pyrite formation model (D. Rickard); Mathematical models of diagenetic processes in marine sediments: iron and manganese redox cycling and non-steady-state diagenesis (D. J. Burdige & S. P. Dhakar); Geochemistry and radioactive waste management: issues and conflicts (D. Read).

The immense impact these lectures have created is also due to the effective and efficient way in which the eminent speakers have demonstrated their mastery over the chosen topics with remarkable felicity and finesse. The elegance and splendour of the projections in these keynote lectures, and also in most of the other presentations, superbly matched (or even excelled in some cases) the acme of academic import, apart from heightening the visual treat.

The following (provocative) titles, picked up with certain amount of temerity from a large number of presentations, exhibit the extreme novelty in approach breaking the barriers between different disciplines, and/or the ultra sophistication in instrumentation and methodology: $^{234}\text{U}/^{238}\text{U}$ ratios in Qua-

ternary planktonic foraminifera (G. M. Henderson & R. K. O'Nions); Isotopic composition and diagenetic alteration of Lower Carboniferous brachiopod shells: constraints from proton microprobe (PIXE) trace element analysis (F. Bruhn & others); Palaeocirculation reconstruction by neodymium isotopic ratios of marine baryte (A. Paytan & M. Kastner); Inorganic geochemistry of organic-rich sediments: palaeoceanographic evidence from the Eastern Mediterranean and Sea of Japan (G. O'Sullivan & others); Sulphur transport and sulphur isotopic fractionations in ocean floor hydrothermal systems (M. J. Bickle & others); A study of precious-metal concentrations in oceanic sediments (D. Green & others); Dating of granulite facies metamorphism and depletion: SIMS chronometry of microscale monazite inclusion in garnet (X. K. Zhu & others); The thermal history of the lower crust recorded by zircon growth and recrystallization: an ion microprobe (SHRIMP) study from the Ivrea zone (Southern Alps) (G. Vavra & others); Micron-scale isotopic zoning in minerals: a record of large-scale geologic processes (M. A. McKibben & C. S. Eldridge); Platinum group mineralization in the Bushveld Complex: a combined QEM-SEM and LA-ICPMS study (T. E. McCandless & others); I.C.P. magnetic sector multicollector mass spectrometry and its applications to geochemistry (A. N. Halliday & others); The application of nuclear microprobe analysis and secondary ion mass spectrometry to radioactive waste disposal studies (J. A. Berry & others); Lower mantle mineral associations preserved in diamonds (B. Harte & J. W. Harris); Applications of *ab initio* quantum-mechanical potential surfaces to mineral physics calculations (Y. Xiao & A. C. Lasaga); Superimposing magma chamber and melting regime processes: how easy is it to (mis)interpret the liquid products? (M. J. O'Hara); Cosmic dust: terrestrial accretion rate and solubility in seawater (B. Peucker-Ehrenbrink & others); Fluid flow in Vermont and New Hampshire, USA: a 3-D perspective (A. D. L. Skelton); 3-D ^{40}Ar - ^{39}Ar geochronology in the Parana flood basalt province (K. Stewart & others)

The following titles with a regional flavour, particularly with reference to India and the adjoining countries, are bound to excite interest among Indian scientists: Fluids in Yakutian and Indian diamonds (M. Schrauder & others);

Tectonic and thermal evolution of south India during the Pan-African orogeny (J. M. Bartlett & others); The leptynitic gneisses of the Kerala Khondalite Belt, southern India: phenomena and mechanism of dehydration/melting at granulite facies conditions (I. Braun & M. Raith); The Kondapalli layered complex, Andhra Pradesh, India: geology, mineralogy and chemistry (C. Leelanandam); Ar–Ar constraints on erosional versus extensional unroofing in orogenic belts, the Zaskar Himalaya, NW India (D. Vance & S. Kelley); Constraints on the thermal evolution of the Indian Himalaya from manganese and erbium distributions in metapelitic garnets (M. Ayres & D. Vance); Partial melting features of metamorphosed ores from Rangpo polymetallic deposit (Sikkim, India) (N. N. Mozgova & others); Contrasting fluid-deformation-melt histories within the High Himalayan crystallines, Langtang Valley, Nepal (J. A. Massey); Metamorphism and melting within the Nanga Parbat syntaxis, Pakistan Himalaya (P. J. Treloar & others).

The following presentations, picked up at random, may have some relevance to the research projects now in vogue in India. Gold behaviour in the process of acid magma crystallization (R. N. Sobolev); Mercury as pathfinder in geochemical exploration of hydrothermal gold–silver deposits in Kamchatka (V. M. Okrugin & others); The influence of open-cast lignite mining on adjacent ground water systems (U. Maiwald & A. Pekdeger); Carbonatites and mantle evolution: a review (K. Bell); Evolution of the lower continental crust during post-thickening collapse (S. Costa & others); O₂ and CO₂ in the Late Archean and Early Proterozoic atmosphere (H. D. Holland & others); Chemical disequilibrium during crustal anatexis (N. Harris & others); Mantle-derived CO₂ and granulite genesis: evidence from noble gases (T. J. Dunai); Two cycles of granulite facies metamorphism detected by Sm–Nd dating of garnet: implications for the Sm–Nd closure temperature (B. J. Hensen & B. Zhou); Contrasting geochemistry of granulite-facies leucosomes and S-type granites: K-feldspar as culprit (D. P. Carrington & G. R. Watt).

The 37 oral and 7 poster presentations under theme 12 are particularly relevant to all the metamorphic petrologists working on the Pre-Cambrian rocks from Peninsular India, and this delegate has attended almost all of them. This

symposium section forms part of the activities of the prestigious project IGCP 304 on Lower Crustal Processes and includes the following 4 sessions: Melting, melt segregation and related processes; Melting and high-grade case studies; Fluids in high- and medium-temperature cases; Collision, subduction and fluids. The reputed speakers include, among others, M. Brown, D. J. Waters, D. Vielzeuf, B. J. Hensen, S. L. Harley, I. C. W. Fitzsimmons, F. Spear, D. R. M. Pattison, T. Chacko, P. I. Nabelek, K. Mezger, J. L. R. Touret, T. J. Dunai, I. S. Buick, I. Cartwright, M. J. Bickle, C. Cole, M. R. Wilson, B. W. D. Yardley and A. C. Barnicoat, whose valuable contributions, including their latest ones, are so familiar to all the active petrologists. Due to constraints on space, and for no other reason, titles of the excellent papers under this and other symposium themes (especially nos. 4–9) are not given here.

Coming to some statistics of the conference, a total of 374 oral presentations (including 34 keynote lectures), 132 poster presentations and 5 plenary lectures (each of 60–75 min duration) were delivered under 15 symposium themes conducted in 5 or 6 parallel sessions (with a total of 46 sessions) for 4½ days. A few sessions were unusually decorated with 3 keynote lectures, instead of the customary 1 keynote lecture per session, strangely, a few sessions and also themes were devoid of keynote lectures. For example, the three symposium theme nos. 1, 7 and 9 do not have any keynote lectures, while the three themes nos. 2, 13 and 14 put together (with 18 sessions and 212 presentations) have nearly half the number (16) of the total number of keynote lectures (34) for the entire conference. The six symposium themes nos. 4–9 (with 15 sessions and 181 presentations), which constitute altogether a radically different group, surprisingly, have only 9 keynote lectures. Two highly contrasting symposium themes nos. 13 and 4 have amazingly attracted the largest and next largest number of presentations (84 and 73, respectively). This foretells the vigour of research themes to be pursued in this country as well in the years to come. A maximum of 11 presentations (each of 20 min duration) were made, in general, at each of the sessions, which lasted from 9 a.m. to 12.40 p.m., and further from 2 p.m. to 5 p.m. without coffee/tea breaks (though these beverages are available free of charge in the

general concourse!). A major disadvantage inherent in the parallel sessions is that the delegates can attend only the most lucrative lectures, at the expense of other equally attractive lectures, due to scientific compulsions, and often it was not that easy for some delegates to take 'decisions' as they are personally pledged to the speakers or academically wedded to the topics. More than 570 scientific registrants (of whom graduate students constitute nearly 20%) and 32 accompanying persons, from 34 countries, have participated in the conference. Eleven countries (including India) were each represented by one delegate only, while the representation was considerably high from the UK (154), USA (104), Germany (69), France (39), Canada (29), Switzerland (23), Russia (19) and Australia (18).

From a non-geochemical (?) angle, the exciting events of the conference were the three receptions (welcoming, poster and farewell), each supposedly meant for a specific purpose, but all arranged to cater to the desires of the (academically) thirsty participants. The most enjoyable event and certainly the high point was the Civic Reception, given by the Lord Provost of the City of Edinburgh, on 1 September, in the majestic concourse of the Royal Museum of Scotland, followed by the banquet – a gourmet's delight – served in a stately Scottish style. It was during this banquet that A. C. Lasaga (President of the Geochemical Society) announced the award of the Goldschmidt Medal for 1994 to H. D. Holland, and C. J. Allègre expressed sincere thanks, on behalf of all the delegates, to Ben Harte (Edinburgh University), who had done a commendable job as the Chairman of the 15-member Organizing Committee and also as the Principal Editor of the 40-member Editorial and Programme Committee, for the overwhelming success of the Conference. Immediately after the banquet, the joyous delegates had the great good luck of witnessing, as if it was pre-arranged, the awe-inspiring and dazzling display of fireworks from the nearby imposing Edinburgh Castle which marked the conclusion of the Edinburgh International Festival (14 Aug–3 Sept. 1994).

In the afternoon of 31 August, the delegates had a most enlightening experience of visiting the Geology and Geophysics Department (which houses the irresistible ion microprobe), the British Geological Survey and the leg-

endary Holyrood Park (including the famous Hutton's locality on spectacular Salisbury Crags). Much to the chagrin of certain connoisseurs, the official programme for an exciting visit to the Scotch Whisky Heritage Centre for discovering the history and mystery of the Spirit of Scotland was scheduled for accompanying persons (only).

A number of invigorating field excursions were arranged (3-11 September) for the participants to view the renowned geology and scenery of the Scottish Highlands and Islands (Ballachulish, Great Glen; Kinlochberrie, Northwest Highlands; Sligachan, Isle of Skye) with Keith O'Nions, Mike O'Hara, Ben Harte, David Pattison and others as leaders. This is indeed an

added academic attraction of the Conference and an unforgettable geological feast, in the true sense, to the participants

The two-page extended abstracts of all the papers (oral and poster presentations) were printed and brought out as a voluminous special number (vol. 58A) of the magnificent *Mineralogical Magazine* (published by the Mineralogical Society, London) in two parts: the first part containing Abstracts A-K (pp. 1-504) and the second part containing Abstracts L-Z (pp. 505-1009). The first part also contains a useful Author Index (pp. ii-viii) and an informative Subject Index (pp. ix-xxxii). Seven erudite participants (S. L. Goldstein, B. Harte, C. J. Hawkesworth, A. W. Hofmann, R. K.

O'Nions, N. Shimizu & B. J. Wood) authored or co-authored 6 or more than 6 abstracts; they consumed, along with their co-authors, a total of 92 out of 1009 pages! This vol. 58A of the *Mineralogical Magazine* is destined to become an inexhaustible storehouse of geochemical information in the widest sense and also an exceedingly valuable reference work of long-lasting value.

The scientific excellence and organizational grandeur of the 1994 VM Goldschmidt Conference made it a truly memorable one.

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SCIENTIFIC CORRESPONDENCE

Geochemical basis of tropical endomyocardial fibrosis

We have the following comments on the letter from P. V. Sukumaran¹:

1. Our studies show an overlap in the incidence of endomyocardial fibrosis with the areas where deposits of monazite occur in Kerala. Cerium tops the list by percentage weight among rare-earth elements (REE) in monazite. Since the cardiac tissues of patients contain more cerium and, to a lesser extent, thorium than the control samples, it is logical to pursue the possible pathogenetic role of cerium in the disease. Cerium is the most soluble among REE and is concentrated by planktonic algae and probably tubers. How it gets into the cardiac tissues remains to be worked out. It is, however, likely that the deficiency of magnesium may enhance the absorption of cerium through the gut as it does for certain other toxic elements like Pb and Al.

2. The impression that REE are stable and the chances of their uptake by plants are remote is not necessarily correct. While the major portion of the monazite may be insoluble and hence not bioavailable, the work on coconut palms shows that they can accumulate cerium from the environment². Similarly, a laboratory experiment using *Coleus parviflorus* has shown that plants can accumulate cerium from the experimental culture medium³. In fact, a

geochemical hypothesis has been suggested for the causation of root (wilt) disease in coconut palms. The possible factors that may govern the uptake of REE from the environment are discussed elsewhere⁴.

3. The map of Kerala was given merely to indicate the preferential deposition of monazite along the coastal strip, where most of the patients also come from. The deposits did not claim to indicate their minability or mechanism of deposition.

4. Elevated levels of REE and Th in faeces denote the consumption of these elements and their probable route of entry into body tissues.

5. Mere presence of certain elements in the soil does not suggest a causal role for them in disease. The claim that other elements such as Al present in Kerala soil should lead to increased incidence of Alzheimer's disease is, therefore, naive. In studying pathogenesis, the reason to look at certain elements is their high or low level in human tissues and not their concentration in the soil. Geochemical aspects are important to the extent they are necessary for investigating the pathogenetic mechanisms of RE and other elements.

1. Sukumaran, P. V., *Curr Sci*, 1994, 67, 976.

2. Valiathan, M. S., Eapen, J. T. and Mathews, C. K., *Curr. Sci*, 1992, 63, 565
3. Nair, R. R., Gupta, P. N., Valiathan, M. S., Kartha, C. C., Eapen, J. T. and Nair, N. G., *Curr Sci*, 1989, 58, 696
4. Eapen, J. T., *Indian Coco J*, 1993, 24, 3.

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P. V. Sukumaran's reply:

Though I have clearly mentioned the shortcomings of the paper by Valiathan *et al*¹ from a geologist's point of view², I am elaborating below some of the points which may not occur to a medical scientist: