The LIP Reader

Newsletter of the Commission on Large-Volume Basaltic Provinces
IAVCEI International Association of Volcanology and Chemistry of the Earth's Interior

Number10 November 1997

This Issue...

Leader

Mike Coffin
Institute for Geophysics
The University of Texas at Austin
4412 Spicewood Springs Road, Bldg. 600
Austin, TX 78759-8500, USA.
Tel: 1.512.471.0429
fax: 1.512.471.8844
internet: mikec@coffin.ig.utexas.edu

Secretary

John Mahoney
Department of Geology and Geophysics
School of Ocean and Earth Science and Technology
University of Hawaii
2525 Correa Rd.
Honolulu, HI 96822, USA.
Tel: 1.808.956.8705
fax: 1.808.956.2538
internet: jmahoney@soest.hawaii.edu

Newsletter Production

Janelle L. Berry, Lisa Gahagan and Toni Lee Mitchell

The 1998 IAVCEI Congress in Cape Town, South Africa, promises to be the highlight of the upcoming year for many CLVBP members, and we hope to see as many of you as possible on the flanks of Table Mountain. Plans are also being laid for stimulating LIP sessions at the 1999 IUGG General Assembly in Birmingham, England. In this issue, summaries of recent meetings in Ethiopia, California, and Japan are highlighted. Contributions to *The LIP Reader*, including recent research results, are welcomed. Please inform your colleagues about the CLVBP and our activities.

IAVCEI News

Our South African colleagues are gearing up for a superb IAVCEI Congress, "Magmatic Diversity -Volcanoes and Their Roots," in Cape Town next July. Eleven symposia, six pre-Congress excursions, six mid-Congress excursions, and seven post-Congress excursions hold much in store for students of large-volume basaltic provinces. For full details on the Congress, see: http://www.uct.ac.za/depts/geolsci/ivc98/

CLVBP News

Leadership

Nominations for new CLVBP leadership have been received by the Steering Committee and are currently being evaluated. New leadership is anticipated to be in place by early 1998.

CLVBP-U.S. National Science Foundation Dialogue

Efforts to develop a LIP initiative at the U.S. National Science Foundation are continuing. The Steering Committee has received input from CLVBP members on: 1) the fundamental scientific issues involving LIPs, 2) the rationale for NSF to fund a LIP initiative, and 3) a rough 10-year projected budget for a LIP initiative. A group of U.S. CLVBP members plans to present and discuss the potential LIP initiative with the relevant NSF program officers in Washington, D.C., in the first half of 1998. We continue to welcome input from all CLVBP members regarding your views and ideas on a potential LIP initiative—please send suggestions to Mike Coffin or John Mahoney.

Large Igneous Provinces: Continental, Oceanic, and Planetary Flood Volcanism

The American Geophysical Union (AGU) is publishing ***Large Igneous Provinces: Continental, Oceanic, and Planetary Flood Volcanism*** as Geophysical Monograph 100, and the volume will be available at the Fall 1997 AGU meeting. For more information on the monograph, including the table of contents, see: http://www.agu.org/

Steering Committee

An updated list of Steering Committee members and their addresses follows:

Nick Arndt (Univ. of Rennes, France) ..... arndt@univ-rennes1.fr
Hans Barsczus (Univ. of Montpellier, France) ..... barsczus@sajou.dstu.univ-montp2.fr
Ian Campbell (Australian National Univ., Australia) ..... ihc1561@huxley.anu.edu.au
Mike Coffin (Univ. of Texas, USA) ..... mikec@coffin.ig.utexas.edu
Keith Cox (University of Oxford, UK) ..... Keith.Cox@earth.ox.ac.uk
Geoff Davies (Australian National Univ., Australia) ..... geoff@rses.anu.edu.au
Bob Duncan (Oregon State Univ., USA) ..... rduncan@oce.orst.edu
Jean Goslin (Univ. of Brest, France) ..... goslin@univ-brest.fr
Chris Harris (Univ. of Cape Town, South Africa) ..... kv@geology.uct.ac.za
Chris Hawkesworth (Open Univ., UK) ..... C.J.Hawkesworth@open.ac.uk
Jim Head (Brown Univ., USA) ..... head@pggipl.geo.brown.edu
Jan Hertogen (University of Leuven, Belgium) ..... jan.hertogen@geo.kuleuven.ac.be
John Hopper (Danish Lithosphere Centre, Denmark) ..... jrh@dlc.ku.dk
Rosaly Lopes-Gautier (Jet Propulsion Lab, NASA) ..... rlopes@jpluvs.jpl.nasa.gov
John Mahoney (Univ. of Hawaii, USA) ..... jmahoney@soest.hawaii.edu
Sverre Planke (Univ. of Oslo, Norway) ..... sverre.planke@geologi.uio.no
Jakob Skogseid (Univ. of Oslo, Norway) ..... jakob.skogseid@geologi.uio.no
Kensaku Tamaki (Univ. of Tokyo, Japan) ..... tamaki@ori.u-tokyo.ac.jp
Dominique Weis (Free Univ. of Brussels, Belgium) ..... dweis@resulb.ulb.ac.be
Dave Williams (Univ. of Alabama, USA) ..... dwillia3@wgs.geo.ua.edu

Full addresses and contact numbers for the above are available over the internet, on diskette, or as hard copy (see below) from Mike Coffin.

Recent Research Summary

To view and obtain an online version of Cordery, M. J., G. F. Davies, I. H. Campbell, Genesis of Flood Basalts from Eclogite-Bearing Mantle Plumes, *Journal of Geophysical Research, 102*, 20,179-20,197, 1997:
(1) Connect to s122.es.llnl.gov
(2) cd users/cordery/papers
(3) Download either CFBPaper.ps.Z (UNIX machines) or CFBPaper.sit.sea.hqx for self-expanding Mac version.

Previous Meetings

Flood Basalts, Rifting, and Paleoclimates in the Ethiopian Rift and Afar Depression, Addis Ababa, Ethiopia, 3-14 February

The remarkable geology of northeastern Africa, which includes the Ethiopian flood basalts (one of the youngest major examples of this type of volcanism), the Afar depression (the site of junction of two oceanic ridges), and the continental East African Rift or Ethiopian Rift (site of numerous crater-bound lakes providing an excellent record of climatic conditions extending back over 30 kyr), was the focus of an international conference which marked the end of an initial phase of cooperative research by scientists from France, Djibouti, and Ethiopia. The meeting was attended by about 100 Earth scientists, the majority from the three cooperating countries plus Eritrea and Yemen, but included participants from eight other countries. Three days of formal discussion were preceded by field trips to the flood basalts and sites of paleoclimatic interest, and were followed by a trip to the Afar depression. The meeting and field trips were sponsored by the Institut National des Sciences de l'Univers du CNRS France, the French Embassy in Ethiopia, the Institut Supérieur d'Etudes et de Recherches Scientifiques et Techniques of the Republic of Djibouti, and the Department of Geology and Geophysics of the University of Addis Ababa in Ethiopia.

The particular importance of the flood basalts was outlined by V. Courtillot and co-workers, who emphasized the following features. The province can be considered one of the youngest major examples of this type of volcanism, and the rocks are unusually well preserved. Their eruption coincided with the start of continental rifting and plate divergence that continues to the present day in the Afar depression. Plate movements were slow (~2 cm/yr) and the distance between the volcanic plateau, which is thought to mark the site of initial plume melting, and the presently active rifts is small. The region therefore represents an ideal situation to investigate the relationships among plumes, flood volcanism, and rifting.

Various speakers provided new data that contributed to our knowledge of the flood basalts. C. Hofmann and co-workers used a combination of $^{40}Ar/^{39}Ar$ dating and paleomagnetic results to show that the Ethiopian Traps, like other major flood basalt sequences, erupted in a very short time, probably less than one million years, at about 30 Ma. They related the event to global climatic changes such as the onset of Antarctic ice sheets and a major fall in sea level. The petrological and geochemical characteristics of the basalts were discussed by Pik, Yirgu, Deniel, and others who showed that both low-Ti and high-Ti types were present in the province and who demonstrated the involvement of at least two types of mantle source and of continental contamination in the petrogenesis of the volcanic rocks. Rogers and George provided new and valuable information on the geochemistry of flood basalts from the southern part of the country, as did Al'kadashi for the equivalents in Yemen. Finally, Marty et al. presented He isotopic data that delineated the past and present extent of the Ethiopian plume.

Tectonicists at the meeting emphasized the advantages offered by the entire region in the study of the tectonic causes of continental rifting and seafloor spreading. Two oceanic ridges, in the Red Sea and Gulf of Aden, are currently propagating towards the Afar depression, as a result of the separation of Arabia and Africa. Manighetti and co-workers showed that rifting and propagation along the Aden ridge began about 30 Ma, at the time of the Ethiopian Trap emplacement. The rift then propagated WSW through the Gulf of Aden to Afar as the result of an episodic process due mainly to complex interaction between the 3D plate geometry and the direction and intensity of regional stress. Propagation of rifting was first rapid (>10 cm/yr) and then slower (a few cm/yr) as the Aden rift reached the plume area, as shown by Huchon and co-workers. Cochran and Bonatti showed that rifting and its propagation along the Red Sea proceeded through the development of disconnected cells.

The Aden and Red Sea rifts are currently propagating into Afar, trying to connect and thus to completely separate Arabia and Africa. Manighetti and co-workers showed that rifting is concentrated along rift belts on both sides of the Afar depression, where lithosphere is thinnest. These belts comprise disconnected rifts that propagate northwestwards along the onland continuation of the Aden ridge, and southeastwards along the continuation of the Red Sea. Most exhibit geometries and features similar to overlapping oceanic ridge segments, as pointed out by Macdonald, who recognized common "volcanic growth faulting." Transfer of extension between rifts is accommodated by a bookshelf-faulting mechanism, implying fast block rotations, some of which have already been confirmed by paleomagnetic and K-Ar results. The same mechanism operates at larger scale to transfer strain between the Aden and Red Sea emerged plate boundaries. From their extensive paleomagnetic study, Kidane and co-workers showed that the amount of block rotation decreases westwards, as a result of the westward propagation of the whole Aden rift zone. Between the two plate boundaries, where large blocks rotate clockwise, Jacques and Tapponnier identified smaller zones of opposite vorticity, resulting from local kinematic compatibilities. One of the smaller zones was the site of northwestward propa-

gation of faulting during the last major earthquake in August 1989. Lepine and co-workers related the seismicity in the Gulf of Tadjoura to the finite Quaternary deformation.

The two emerged rift zones in the Afar depression offset the long East African rift system to the north. Bocaletti showed that this system is still active, though slower moving than the other plate boundaries. Oblique rifting along the East African rift generated active faulting associated with intense mafic to felsic volcanism, as studied by Bocaletti and Peccerillo. At larger scales, Hayward related tectonic and volcanic changes along the East African rift north to the Afar depression to changes in the structure of the lithosphere, in particular its elastic plate thickness. King suggested a new view of the lithosphere, which could be considered as primarily elastic. Finally, the Afar rifting was evaluated in light of previous work in oceanic environments by Hey, Macdonald, and Taylor, who found some striking similarities, and who emphasized the need for complementary studies.

Many characteristics of the Ethiopian province can be explained in terms of classic models in which the occurrence of flood basalts and continental rifting are related to the arrival of a new mantle plume at the base of the lithosphere. In a model developed by Courtillot and others, which is intermediate between the classic models of "active" and "passive" rifting, the plume head is said to have influenced a vast area within which a major rift system in the Indian Ocean was guided along a path of least resistance after its original link to the Indian subduction zone through the Owen fracture zone became blocked by collision with India. Although such a model explains many aspects of the relationships among the plume head, the active hotspot, and oceanic and continental rifts, certain features of the volcanism and tectonics of Ethiopia pose problems. Unlike the situation in the North Atlantic Tertiary province, where continental rifting immediately preceded continental volcanism and resulted in the eruption of enormous volumes of basalt now preserved in seaward-dipping reflector sequences, rifting of Arabia and Africa created oceanic crust of normal thickness. The magmas that are currently erupting along the active rifts have transitional to alkaline geochemical characteristics and appear to have come from a relatively cool mantle source. If a large-volume "plume head" ever existed, it appears to have been an ephemeral feature that disappeared within 10 Myr, at the time of the onset of continental rifting in the Afar depression. Other outstanding problems include questions specific to the Ethiopian province—the relationship between the traps in the northwest and south of Ethiopia, the origin of the felsic volcanics, the relationship between the main 30 Ma traps and the ~2 Ma stratoid sequence; and questions of wider significance such as the relationships among flood volcanism, continental rifting, and global climate change.

These questions provide ample reason to continue research in the Ethiopia-Afar region. The need to continue the project was recognized at the end of the Addis Ababa meeting and provided the impetus to prepare a second four-year program. A formal proposal has now been written as is currently being evaluated by authorities in France, Ethiopia, Djibouti, and several other countries.

A full meeting report has been submitted to *Eos, Transactions American Geophysical Union.*

contributed by Nicholas T. Arndt (Université de Rennes, France) and Isabelle Manighetti (Institut de Physique du Globe, Paris, France)

The History and Dynamics of Global Plate Motions, Marshall, California, USA, 17-22 June

Since the advent of plate tectonic theory three decades ago, two principal goals of global geodynamics have been to determine the forces that drive plate motions and to explain the relationship between global plate motions and mantle convection. Progress in geophysical modeling of plate motions and seismic imaging of the Earth's interior, combined with continuing advances in reconstructing the history of plate motions, are now yielding rapid advances in understanding the relationship between plate motions and deep mantle processes. Powerful 3D numerical models are now capable of resolving the vigorous dynamical regime of high Rayleigh number convection in the Earth's mantle. Geodynamic models now incorporate the history of plate motions explicitly in seeking to explain the thermal state of the mantle now and in the recent past. Simultaneously, seismological studies have mapped lateral velocity variations in the mantle: regional seismic studies beneath subduction zones image the trajectories of cold slabs as they sink in the mantle, and global studies also reveal warm upwelling structures and their relation to plate boundary processes and volcanic hotspots. Progress in plate tectonics includes more tightly constrained reconstructions (from better survey coverage of the seafloor) and the use of satellite gravity data to deduce aspects of seafloor evolution that were previously invisible beneath sediment or in regions lacking shipboard geophysical data.

These advances have increased interactions between "deep Earth" geodynamicists/seismologists and the geologists/geophysicists who study the kinematics of plate motions. To further this interdisciplinary dialogue, an American Geophysical Union Chapman Conference, co-sponsored by CSEDI and JOI/USSSP, on "History and Dynamics of Global Plate Motions" was held at Pt. Reyes National Seashore, astride the section of the San Andreas Fault that ruptured in the great 1906 San Francisco earthquake. The Marconi Conference Center was the venue for 116 scientists representing 18 nations during four days of lively debate and interchange, and one day of intraconference field trips. The interdisciplinary nature of the meeting was underscored by the titles of the principal sessions: (I)

Pacific Basin Plate Motions and Hotspot Fixity, (II) Mantle Plumes and the Hotspot Reference Frame, (III) Pre-Mesozoic Plate Motions, (IV) Modeling Plate Motions and Intraplate Stresses, (V) Seismic Imaging of Subducted Lithosphere, (VI) Intraplate Deformation and Diffuse Plate Boundaries, and (VII) Geodynamic Modeling of Plate Boundaries and Dynamic Topography. Evening tutorial sessions on Error Analysis in Plate Reconstructions, Plate Driving Forces and Mantle Convection, and Software for Plate Tectonics helped to further bridge the interdisciplinary gaps.

The conference was somewhat a remarriage of geodynamic modeling and information from the geological record of global plate motions. Meeting participants recognized an overwhelming need for better organization of information on past plate motions for the purposes of geodynamics as well as geology, and agreed that a major, sustained effort should be undertaken to produce an integrated data base of plate rotations, plate boundaries, plate ages, and attendant uncertainties using consistent magnetic anomaly picks. In turn, these reconstructions must be used carefully in ever-more-powerful computer models to test a broad range of hypotheses regarding the forces acting on plates, the fundamental rheological nature of plate boundaries, the fate of subducted slabs in the deep mantle, the origin of volcanic hotspots, and the geologic record of intraplate deformation and vertical motions of the Earth's surface. Ultimately, one would hope to incorporate plate motion constraints from the seafloor and paleomagnetics, geological observations of uplift and deformation, and seismic imaging of mantle heterogeneity into integrated, self-consistent models of the geological evolution of specific regions of the Earth. Many participants at the meeting felt that the interdisciplinary walls were just beginning to crack and suggested re-convening in a few years to check progress.

A full meeting report is in press with *Eos, Transactions American Geophysical Union.*

contributed by Mark A. Richards (University of California, Berkeley, USA) and Joann M. Stock (California Institute of Technology, USA)

Conference on Cooperative Ocean Riser Drilling (CONCORD), Tokyo, Japan, 20-22 July

More than 150 leading international Earth scientists and drilling engineers reached a clear consensus on the need for a new generation deep-water drilling vessel, equipped with a riser, or riser-type system, that can circulate drilling fluids, provide well control, and thus allow access to deeper and more challenging environments. This major research facility, proposed by the Japan Marine Science and Technology Center (JAMSTEC), will open up a new and exciting phase of scientific exploration, with consequent societal and economic benefits. Japan's commitment to this major capital investment was universally welcomed by CONCORD participants, and is seen as evidence of its emerging leadership in marine science.

Conference participants identified a range of fundamentally important scientific problems that can be addressed only by drilling deeper into the Earth. They agreed that the understanding of major earthquake processes through direct observation and monitoring should be the first priority of a new riser drillship. Key problems identified further include:

- searching for new species of ancient, but still living bacteria that lie deep within marine sediment and oceanic crust;
- extending the record of natural climate variability to at least 180 Ma, and the determination of the history of, and environmental conditions associated with, significant past "greenhouse" climate events and related sea level change;
- the record of past "super volcanic" (i.e., LIP) events in the ocean basins, their relation to the dynamics of the deep Earth, and their impact on global climate. Specific targets include oceanic plateaus (one or more deep holes), seaward-dipping volcanic wedges on divergent margins (several deep holes), and possibly a volcaniclastic apron adjacent to an oceanic plateau (one deep hole);
- the nature of oceanic crust, which constitutes two-thirds of the Earth's surface, the dynamics of its formation and alteration, including drilling through the entire crust and into the upper mantle (the "21st Century Mohole"); and
- the formation of continents, the breakup of continents, and the evolution of their sedimentary basins along margins, many of which are rich in hydrocarbon deposits.

Resolution of these important scientific problems is critical to achieving a better understanding of the dynamic processes that shape the planet's surface, cause earthquakes and volcanism, control formation and distribution of petroleum and mineral resources, and regulate Earth's climate. Achieving many of these objectives will require installation of arrays of sub-surface deep-sea observatories that can monitor our dynamic and evolving Earth.

CONCORD participants were in full agreement that resolution of the above key scientific problems requires drilling to greater depths than currently possible. It requires a concerted international scientific effort, which must highlight deep drilling. Riser, or riser-type drilling, involving circulation of dense, viscous drilling fluids, is critical for well stability and sub-surface fluid control. Nonetheless, there will be a continuing role for a drilling vessel that is not equipped with a riser, and is similar to that operated by the current Ocean Drilling Program (ODP). Such a drillship is necessary for ongoing, high resolution sediment studies and exploration of shallower crustal sections. It can also provide pilot holes that support later riser drilling. A multiple platform, scientific ocean drilling program beyond

2003, as envisaged in the 1996 ODP Long Range Plan, was endorsed at CONCORD. The participants encouraged the emerging cooperation among Japan, the United States, and other ODP partner countries in making possible a future Integrated Ocean Drilling Program (IODP), and encouraged even wider international involvement.

The new generation deep-water drilling vessel proposed by JAMSTEC should be equipped initially with a riser, that will enable controlled drilling and rock core recovery in 2,500 to 3,000 meters of water, and up to 7,000 meters beneath the seabed. CONCORD urged that the new drillship be available by 2003, and encouraged further development of appropriate technology, which will eventually enable riser-type drilling in at least 4,000 meters of water. To ensure that this new scientific research facility is at the leading edge of technology, JAMSTEC will continue to both work in close cooperation with commercial deep-water petroleum exploration drilling operators and further develop links with ODP.

ccontributed by CONCORD Steering Committee and Working Group Co-Chairs

Synopses of recent meetings are welcomed—please send your ≤200 word review to Mike Coffin or John Mahoney.

LIPS and the Ocean Drilling Program

The next proposal deadline is 15 February 1998. For more information on planned legs, proposal guidelines, and panel structure, see the JOIDES web page (www.whoi.edu/joides). John Mahoney represents the CLVBP as a member of the Interior SSEP.

Commission Products and Services

LIPs on Internet

LIPs have an Internet presence, accessible via standard Internet tools. The Commission's LIP bibliography of ~4650 references, directory of ~600 members, and digital database of LIP areas (Figure 1 of Coffin & Eldholm, *Reviews of Geophysics*, 1994) are available, as well as the calendar of events and text versions of *The LIP Reader*. Should individual scientists have improved outlines of LIP areas available digitally and be willing to make these available over the Internet, please provide a digital file to Mike. The Internet site is currently set up as a Gopher server, which allows users to log in with anonymous ftp or WWW tools, such as Netscape or Internet Explorer. As time allows, the site will be enhanced for WWW users. Ideas on how the site could be improved are most welcome. For copies of materials on Macintosh diskette, please send a blank 3.5-inch diskette to Mike.

Anonymous FTP

With ftp, open "utig2.ig.utexas.edu", use the login name "anonymous" and your Internet address as the password. Change directory to "outgoing/lips".

Gopher

Using your Gopher client software, open "gopher.utexas.edu". Navigate to "UT Austin", to "Colleges and Departments", to "Institute for Geophysics", to "Research Projects", and then to "Commission on Large Igneous Provinces".

World Wide Web

The Universal Resource Locator (URL) is http://www.ig.utexas.edu/research/projects/lips.html

UPCOMING MEETINGS

8-12 December: **American Geophysical Union Fall Meeting,** San Francisco, California, USA. Special sessions: ***Evolution of the Paraná-Etendeka Large Igneous Province and the South Atlantic Continental Margins; Geodynamics of Giant Magmatic Ore Systems; Geoscientific Studies in Yellowstone National Park in the 1990s: Session Honoring Rick Hutchinson; The Kerguelen Plateau and Archipelago: Recent Geophysical, Geochemical, and Petrological Results; Mantle Melting and Geochemistry; Plate Tectonics and Mantle Plumes; Remote Sensing of Active Volcanism.*** Information: AGU Meetings Dept., 2000 Florida Ave., N.W., Washington, D.C. 20009, USA. Telephone: 1.202.462.6900. Facsimile: 1.202.238.0566. Internet: meetinginfo@kosmos.agu.org. WWW: http://www.agu.org

1998

7-8 January: **Volcanic and Magmatic Studies Group (VMSG) Annual Meeting,** Leicester, United Kingdom. Information: A. Kerr, Department of Geology, University of Leicester, University Road, Leicester LE1 7RH, UK. Internet: ack2@leicester.ac.uk. WWW: http://www.le.ac.uk/geology/ack2/vmindex.html

20-24 April: **XXIII General Assembly of the European Geophysical Society,** Nice, France. Special sessions: ***Dynamics, mineral physics and tomographic imaging of the Earth's mantle; Hot spots and plumes in the mantle; Lithospheric structure in a hotspot frame; Modern rifts: plumes, kinematic conditions and lithospheric inhomogeneities; Rifted margins; Seismology and physics of the Earth's core and mantle; Variations in the Earth's rotation: implications for the dynamics and structure of the mantle and for global change processes.*** Information: EGS Office, Max-Planck-Str. 13, 37191 Katlenburg-Lindau, Germany. Telephone: +49.5556.1440. Facsimile: +49.5556.4709. Internet: egs@copernicus.org. WWW: http://www.copernicus.org/EGS

26-29 May: **American Geophysical Union Spring Meeting,** Boston, Massachusetts, USA. Special sessions: ***The Past, Present, and Future of Oceanic Plateaus; Plumes and Hotspots through Time: Archean to Present.*** Information: AGU Meetings Dept., 2000 Florida Ave., N.W., Washington, D.C. 20009, USA. Telephone 1.202.462.6900. Facsimile: 1.202.238.0566. Internet: meetinginfo@kosmos.agu.org. WWW: http://www.agu.org

11-17 July: **IAVCEI Congress,** Cape Town, South Africa. Symposia: ***Carbonatitic and Alkaline Magmatism from Source to Emplacement; Flood Volcanism; Ultrabasic magmas; Oceanic volcanism; Magmatism related to the Opening of Oceans (MOO); Between magma source and eruption; Relationship between kimberlites, maars and diatremes.*** **Field Trips:** ***Archaean Barberton Granite-Greenstone Terrane; Karoo Volcanism along the Lebombo Monocline; Karoo Volcanism adjacent to Lesotho; Carbonatitic and Alkaline Volcanism in the Northern Province of South Africa; Late Archaean Volcanism of the Gaborone-Kanye Igneous Terrane and the Ventersdorp Supergroup; Volcanic Geology of Réunion Island, Indian Ocean; Komatiites in the Barberton and Nondweni Greenstone Belts; Kimberlites of the Northern Province and Free State; Bushveld Complex; Southern Etendeka Volcanism, northwestern Namibia; Mesozoic Magmatism in northwestern Namibia; Jurassic-Tertiary Volcanism of southern Namibia; Quaternary Caldera Volcanoes of the South Kenya Rift.*** Information: Secretariat, IAVCEI 1998, Department of Geological Sciences, University of Cape Town, Rondebosch 7700, Republic of South Africa. Facsimile: 27.21.650.3783. Internet: ivc98@geology.uct.ac.za. WWW: http://www.uct.ac.za/depts/geolsci/ivc98

26-29 October: **Geological Society of America Annual Meeting,** Toronto, Ontario, Canada. Information: GSA Meetings Dept., P.O. Box 9140, Boulder, CO 80301, USA. Telephone 1.303.447.2020. Internet: meetings@geosociety.org. WWW: http://www.geosociety.org

6-10 December: **American Geophysical Union Fall Meeting,** San Francisco, California, USA. Information: AGU Meetings Dept., 2000 Florida Ave., N.W., Washington, D.C. 20009, USA. Telephone 1.202.462.6900. Facsimile: 1.202.238.0566. Internet: meetinginfo@kosmos.agu.org. WWW: http://www.agu.org

The LIP Reader

Institute for Geophysics
The University of Texas at Austin
4412 Spicewood Springs Rd. Bldg.600
Austin, Texas 78759-8500 USA