

- To suitably amend the Patents law to strike a fair balance between public and private interests in case of patents that assert property rights over genetic material.

India needs to propel and inculcate an even more widespread use of scientific investigation in crime, with standards set for facilities, sample collection and training of personnel at the crime scene, that could be further used for DNA analysis or other methods of scientific inquiry.

This would enable that samples of blood, hair, semen, saliva, footprints and other marks at the crime scene to clinch evidence for conviction that would leapfrog quality of scientific investigation in crime. The efficacy of the investigation and high rate of conviction based on using science in criminal investigation would act as a deterrent to future crime perpetrators.

As senior advocate K. T. S. Tulsi, New Delhi aptly put it: 'There is no doubting that DNA is going to overtake the law

enforcement agencies by storm. No one will be able to avoid it. It is like standing on a shore and asking the waves of the sea not to come. What is required is a proper debate about the real value of DNA and whether it fits into the overall picture and what use could be made of it by investigators.'

**Nirupa Sen**, 1333 Poorvanchal Complex, JNU New Campus, New Delhi 110 067, India (e-mail: nirupasen@vsnl.net).

## MEETING REPORT

### Beyond the plume hypothesis

Most terrestrial volcanism occurs along the mid-ocean ridges and oceanic trenches, which constitute boundaries between the giant plates of the Earth's lithosphere. However, the origin of 'hotspots' – centres of midplate volcanism – is currently the subject of vigorous debate. In the past three decades, hotspots have nearly unanimously been ascribed to 'mantle plumes' – hot, buoyant upwellings from the Core–Mantle Boundary 2900 km below the Earth's surface. Hawaii and Iceland are two classic hotspots, and generally assumed to be underlain by deep mantle plumes. Typical signatures of a deep plume are thought to include a low-seismic-velocity region within the mantle, fixity, an age-progressive volcanic track on the plate, non-MORB geochemistry of the magma and high  $^3\text{He}/^4\text{He}$  ratios, a bathymetric swell, and high heat flow. Plate tectonics is thus regarded as an incomplete theory that must be combined with the separate plume model to explain all volcanism on Earth.

This is rapidly changing. The plume model is being attacked on all fronts, and the concept may have been wrong all along. Old assumptions based on which the plume model was invented have been invalidated by new data (see [www.mantleplumes.org](http://www.mantleplumes.org)). For example, global hotspots do not

constitute a fixed reference frame. They do not have the required high heat flow. Non-MORB-like volcanic rocks indicate crustal recycling, not necessarily from the deep mantle. Most hotspot 'tracks' have no systematic age progression and the few that do are explained by alternative mechanisms (e.g. propagating cracks). Low-seismic-velocity regions within the mantle are not necessarily hot, but can instead be partially molten or  $\text{CO}_2$ -rich. High  $^3\text{He}/^4\text{He}$  ratios do not imply high  $^3\text{He}$  (as in the plume model) but low  $^4\text{He}$ . Such ratios could develop in olivine-rich cumulates in magma chambers because olivine crystals trap  $^3\text{He}$  and have no U–Th (and therefore no  $^4\text{He}$  growth). Remelting of such mafic rocks would produce magmas with high  $^3\text{He}/^4\text{He}$  ratios. The claimed deep mantle plume under Iceland does not exist, and the low-seismic-velocity anomaly under Iceland is confined to the upper mantle.

If plumes do not exist, what then is going on in the depths of the Earth under hotspots? Are the plates themselves responsible for the intraplate hotspots? Are stresses from plate boundaries transmitted for long distances across the plates? Are plates internally deformable and non-rigid? Why should the non-MORB geochemistry of hotspots not be consistent with an upper mantle origin, when so much crustal material is going down the trenches? Is the upper mantle simply peridotitic as assumed in plume models, or both lithologically and geochemically

heterogeneous, containing eclogites and pyroxenites and peridotites, in addition to a potentially vast inventory of volatiles, especially  $\text{CO}_2$ ? To discuss and debate these issues, and to develop models for intraplate volcanism and geodynamics that go beyond the problem-ridden plume model, some sixty-two scientists from twelve nations gathered at the conference. The conference was convened by Gillian R. Foulger (Univ. Durham, UK), James H. Natland (Univ. Miami, USA), and Don L. Anderson (CalTech, USA). The delegates included several students. The conference was broken down into 16 topical sessions, each 90 min long, and comprising two to three keynote talks followed by discussion besides several smaller (5 min) presentations.

G. R. Foulger opened the conference with a welcome address. In Session 1 (Overview: What is a plume? What is a hotspot?), chaired by her and Don Anderson, Anderson gave an overview of the definitions, rules of the game, and the current knowledge. In Session II (What does Seismology Say about Hot Spots?), chaired by Bruce R. Julian (USGS) and Jean-Paul Montagner (Univ. Paris), three keynote talks were given. Adam Dzierwinski (Harvard Univ.) discussed global seismic tomography, what it can and cannot do, and what we know and what we make up. Montagner presented case studies of the Afar and Pacific hotspots, whereas Julian discussed how seismology can be used to 'see' inside the Earth and

Report of the Penrose Conference 'Plume IV: Beyond the Plume Hypothesis', organized by the Geological Society of America, in Hveragerdi, Iceland, between 25 and 29 August 2003.

what variable interpretations are possible. Session III (The Big, Deep Picture), chaired by Scott King (Purdue Univ.) and Don Anderson, comprised two keynote talks. King presented his numerical modelling on plumes and plates. Anne Hofmeister (Washington Univ.) emphasized the importance of mineral physics in the issue of whether plumes can exist.

Session IV (Temperature, Heat and Magma) was chaired by Carol A. Stein (Univ. Illinois, Chicago) and Gudmundur Gudfinnsson (Univ. Texas, Dallas), and included three talks. Stein presented heat flow evidence that 'hotspots' are not hot. John O'Connor (Univ. Kiel) suggested dating ocean island/seamount chains to constrain plate motions and to distinguish deep from shallow sources. Enrico Bonatti (CNR Italy) spoke on the spatial and temporal variations in the thermal mantle structure under mid-ocean ridges. Session V (Opening of an Ocean) was chaired by Gillian Foulger and Greg McHone (Univ. Connecticut). Foulger presented an upper-mantle, plate tectonic model for the volcanism in the North Atlantic, arguing that the excess volcanism at Iceland was due to substantial eclogite (trapped ancient oceanic crust) in the subjacent mantle. McHone discussed volcanic features of the Central Atlantic and evaluated plume- and non-plume models, favouring the latter. Marjorie Wilson (Univ. Leeds) spoke on the plate tectonic evolution of the South Atlantic, discussing such phenomena as propagating fractures.

Session VI (Continental Volcanism and Lithospheric Tectonics), co-chaired by Francoise Chalot-Prat (Univ. Nancy) and Robert Christiansen (USGS), included three keynote speeches. Angelo Peccerillo (Univ. Perugia) discussed the case of central Italian ultrapotassic magmatism. Hetu Sheth (IIT Bombay) argued against the widely accepted plume model for the Deccan Traps, India, and opined that Deccan volcanism was related to continental rifting and breakup. Christiansen argued for lithospheric structural control on Yellowstone, the world's most classic continental hotspot, and concluded, based on his seismic data, that Yellowstone could not be underlain by a deep plume.

Session VII (Extraterrestrial) was chaired by Warren Hamilton (Colorado School of Mines) and Donna Jurdy (Northwestern Univ.). Jurdy and Suzanne Smrekar (JPL-NASA) discussed upwellings within Venus, favouring a plume explanation,

whereas Hamilton ruled out the possibility of plumes within Venus, suggesting that the circular features on its surface were not plume centres but caused by asteroid impacts, and that one should not simplistically assume a Venusian interior similar to Earth's mantle. Scott King opined that the Tharsis Rise on Mars could not be a result of a long-lived mantle plume but may be a result of small-scale convection. Wolf Elston (Univ. New Mexico), with his extensive field experience on the celebrated Bushveld Complex of South Africa, proposed an asteroid impact as its cause.

Sessions VIII and IX (What does Petrology Tell us about Potential Temperatures) were chaired by Dean Presnall (Univ. Texas, Dallas) and David H. Green (Australian National Univ.). Presnall spoke on phase equilibria/seismic constraints on the potential temperature of the mantle, and emphasized the role of CO<sub>2</sub> in the mantle in controlling the solidus. Green argued that there was no evidence from petrology, including experimental petrology, that primary magmas at hotspots were any hotter than primary magmas of MORB. Gudmundur Gudfinnsson highlighted the differences between the most magnesian glasses from Hawaii and Iceland.

Sessions X and XI (Geochemistry and Petrology) were chaired by James H. Natland and Henry Dick (Woods Hole Oceanographic Institution). Natland presented a perspective on mantle geochemistry, arguing for vast lithological and geochemical heterogeneity in the mantle. Dick spoke on the petrology of abyssal peridotites and tholeiites. Richard Walker (Univ. Maryland) suggested that the Re-Os and Pt-Os isotopic systems could be used to determine core-mantle interactions in plume sources. This view was, however, opposed by Alan Smith (Nat. Auton. Univ. of Mexico), who argued that mantle pyroxenites would explain the data as well.

Session XII (Plate Tectonic End Games) was chaired by Martin Flower (Univ. Illinois, Chicago) and Wolf Elston, and Flower discussed the Wilsonian Cycle and mantle melting. Session XIII (Hotspots vs Plate Kinematics and Dynamics) was chaired by Carlo Doglioni (Univ. Rome) and Jerry Winterer (Scripps Institution of Oceanography). Here, Phillip Ihinger (Univ. Wisconsin, Eau Claire) proposed a new 'plumelet' model for Hawaii. Doglioni discussed the apparent

westward drift of the lithosphere relative to the sub-lithospheric mantle. Natland discussed the kinematic evolution of the Pacific plate and changing stress conditions. Winterer argued that seamounts on the Pacific plate reflected stress fields, not plate motions over plumes. Session XIV (Cracks and Tracks), chaired by Alan Smith and Carol Finn (USGS), comprised three talks. Smith presented the case for a regular distribution of Pacific intraplate volcanism, which he related to stress fields within the plate, discounting mantle plumes. Erin Beutel (College of Charleston) explored the idea that hotspots are caused by the lithospheric stress state at the interactions of ridges with transform faults. Finn spoke on a Cenozoic alkaline magmatic province in the southwest Pacific domain without a plume or rift origin.

Session XV (Geodynamic Origin of Large-Volume Basaltic Provinces and Flood Basalts) was chaired by Will Sager (Texas A&M Univ.) and Hetu Sheth. Malcolm Pringle (Scottish Universities Environmental Research Centre) presented new Ar-Ar age data on the Kerguelen Plateau, stating that the duration of volcanism on the plateau is far greater (20 million years) than so far imagined. Godfrey Fitton (Univ. Edinburgh) gave an overview of the Ontong Java Plateau, world's largest, and opined that the plume model was the best explanation for it, though the absence of pre-volcanic lithospheric uplift remained a problem. Sager discussed the tectonic evolution of the Shatsky Rise, and opined that the Rise could be interpreted as a plume head product, or equally well related to evolution of migrating triple junctions. In the final session XVI (Synthesis), Don Anderson and Marjorie Wilson gave summaries of the discussions and the achievements of the conference.

This exciting and scientifically fruitful conference included a half-day field trip to the Reykjanes Peninsula, where the Mid-Atlantic Ridge comes on land, and a full-day field trip around the Western Volcanic Zone and the Hengill ridge-ridge-transform triple junction, which added to the participants' enthusiasm. There were ample opportunities to observe the products of subglacial volcanism, such as hyaloclastite tuyas, and visits were made to the Thingvellir graben, Nesjavellir geothermal power plant, waterfalls, and the famous geysers of Iceland, the great Geysir and Strokkur.

The conference abstracts and other information can be freely downloaded (see [www.mantleplumes.org](http://www.mantleplumes.org)). This website was launched in March 2003 by Gillian Foulger, and its objective is to provide information and generate debate among the scientific community as to

whether plumes exist, what alternatives are possible, and whether they do better at explaining intraplate volcanism and geodynamics than the plume model. New contributions to the website are welcome, and applications should be directed to

Gillian Foulger at [g.r.foulger@durham.ac.uk](mailto:g.r.foulger@durham.ac.uk).

**H. C. Sheth**, Department of Earth Sciences, Indian Institute of Technology, Powai, Mumbai 400 076, India (e-mail: [hcsheth@iitb.ac.in](mailto:hcsheth@iitb.ac.in)).

## FROM THE ARCHIVES



Vol. XI] SEPTEMBER 1942 [No. 9.

### Malaria and antimalarials

Among the several diseases which afflict this country, malaria occupies the foremost place; it is the largest single disease endemic in India. Annually a third of the population of this sub-continent is said to suffer from malaria, and the percentage of deaths among them is appallingly high. Those who survive the attack suffer from its after-effects which often leave a permanent injury on the patient. The loss of economic man-power and human efficiency due to this disease in the British Empire has been estimated at 52 to 62 million pounds a year, more than half of which is shared by this country.

For decades this widespread disease has been allowed to go practically unchecked and no determined and sustained effort commensurate with the magnitude and seriousness of the problem, has been put forward. In this connection, special mention should be made of the Rockefeller Foundation for the valuable services rendered to the Provincial Governments in conducting malarial surveys in the several provinces, and for furnishing the necessary technical personnel.

Methods for combating this disease are well known and they have been widely and successfully adopted in other countries like

Italy and Greece. They consist of the destruction of larvae, the draining of swamps, mechanical protection against mosquitoes and prophylaxis by quinine or atebirin and plasmoquine. The problem in this country is complicated by the undernourished and poverty-stricken condition of its people. The *per capita* consumption of quinine in India as compared with other malaria-stricken countries is only three and a half grains as against the 16 and 24 grains respectively in Italy and Greece. The question of malaria control is, therefore, closely connected firstly, with an adequate supply of prophylactic drugs at prices which the average Indian can afford to pay, secondly with the speed and efficiency with which the sources of vectors could be minimised if not abolished and thirdly, with the raising of the standard of nourishment among the masses.

Cinchona was introduced in India and Java at about the same time; its propagation made considerable headway in this country and at one time it looked as though the country would not only satisfy its requirements but produce a surplus with which a prosperous but not a profiteering export trade could be built up. But Java which was backed up by intensive methods of scientific selection and propagation, evolved varieties which yielded richer percentages of the alkaloid. The Dutch are the foremost in the field of plant improvement and have successfully demonstrated their scientific talent and skill with regard to a number of other economic crops like the sugarcane and the tobacco. The valuable experience in these lines, was utilised for the improvement of cinchona which has been responsible for the supremacy of Java in the production of quinine. Over-production of this drug threatened to reduce the prices to an uneconomic

level but the 'Kina Bureau', a powerful syndicate, stepped in to control the world price of quinine.

So far as mass treatment of malaria is concerned, quinine still holds the field, since the drug can be safely administered and is even recommended for self-medication. But the price of quinine is too high. 'We cannot get away from the fact that quinine is the rich man's remedy, while malaria is the poor man's heritage; but let medicine once admit and practise the value of the other alkaloids and many Indian areas might then be turning out febrifuge at costs more suited to the poor.'

The loss of Java has increased the acuteness of the problem a thousandfold. The price of quinine, which was fixed at Rs 18 by the Kina Bureau has inflated to Rs 130 per lb. The synthetic antimalarials have practically vanished from the Indian market. It is high time that the Government realises the importance of taking immediate steps to make the country self-sufficient with regard to this most important drug. In addition to this, it is necessary that the antimalarial specifics of established reputation in the indigenous systems of medicine, should be investigated with the co-operation of the Pandits and the Hakims. Investigations on the breeding of hardier and richer strains of cinchona should be undertaken and these researches may be appropriately financed by the Imperial Council of Agricultural Research, while researches on synthetic antimalarials are to a certain extent being financed already by the Board of Scientific and Industrial Research. A Central Advisory Board to co-ordinate and direct these activities should be constituted. This is a matter which demands the earnest attention of the Central Government.