MEETING REPORT

Science meets with the Law*

The criminal justice system, such as the Royal Commission on Criminal Justice in England has expressed concern about the criminal process and its propensity to generate miscarriages of justice. Eyewitness accounts of crime scenes are notoriously unreliable, that while traumatic events can leave a photographic imprint, these may be coloured by discussion. Then, there is the unrelenting pressure from the media for bringing the criminals to book. Case laws are replete with wrongful sentencing and conviction by law, only to be exonerated by science. There is much to be done to undo the rough justice and bring proof of innocence, as much as there is to convict wrongdoers. This bubble of rough justice grows bigger, compelling sharing a platform consisting of science and the Law in India.

This is the era of genomics, that of DNA profiling and crime prevention and conviction. Is the legal profession ready for this new information, and how would it benefit the justice delivery system? Is our society ready for implications that genomics brings to every facet of our lives, be it genetically modified food, predictive medicine, genomics-driven drug discovery and human health, and bioterrorism in our midst? Is our society grappling with the ethical and social issues thrown up by new biology, such as those related to *in vitro* fertilization and human cloning, use of animals in biomedical research, and the contentious issues that gnaw at truly collaborative research and development, brought into limelight by Intellectual Property Rights?

Then comes the Law of the Land. India, in its justice delivery system continues to contend with several Laws that are in force, having their origins in the colonial era, such as the Indian Penal Code, 1860, the Indian Evidence Act, 1872, and some already more than twenty-year-old laws, such as the Code for Criminal Procedure, 1973 and the Family Courts Act, 1984. With the rapid progress in science and the advent of new tools of biology, are these laws in their present form, really able to deliver justice efficiently, or does some rethinking in the form of amendments or enacting new Laws become obligatory, in view of the changing clarity that science has brought?

For any major change to be effected, all stakeholders need to sit together and search for answers, for as-yet unsolved problems. This contact, hitherto missing in India between scientists and law professionals became a reality recently, with the first ever conference of its kind held in this part of the world. The conference, whose chief guest was the President of India, A. P. J. Abdul Kalam, formed the basis of the 'Hyderabad Declaration on impact of new biology on justice delivery system' moved by Seyed E. Hasnain, Centre for DNA Fingerprinting and Diagnostics (CDFD) and Ranbir Singh, NALSAR University of Law, both at Hyderabad. CDFD and NALSAR University of Law were the co-organizers of these deliberations that brought together Judges of the Supreme Court of India, Chief Justices and Judges of the High Courts of India, representatives from the Law Commission and the Human Rights Commission, Directors of National Law Schools, National Judicial Academy, other legal luminaries, advocates and IPR lawyers, scientists and doctors, bio-industrialists, NGOs, police investigators, forensic laboratory scientists, university faculty from legal studies and biology fields, science journalists, and a couple of participants from abroad such as Ananda Chakraborty, who is credited with the patenting of the first living form in the world.

The meeting resulted in a declaration that highlighted key issues and emphasized some new initiatives:

- To establish a Human Genetics Commission to provide technical and strategic advice about the current and emerging issues in human genetics, and a consultative mechanism for development of National Genetics Policy and guidelines in that area;
- To establish an Ethics Committee to assess ethical, legal and social issues raised by research on human genome and use of DNA databases;
- To emphasize the need for the establishment of an independent body which may be called the DNA Profiling Advisory Committee and implement quality control measures with reference to DNA profiling, to provide recommendation on the use of current and future DNA methods, to draft an appropriate legislation for all issues concerning DNA profiling, to safeguard the rights of individuals thereunder, to create National DNA Bank for aiding Criminal Justice System;
- To endeavour to make suitable changes in the Code for Criminal Procedure 1973, Indian Penal Code 1860, Indian Evidence Act 1872, the Family Courts Act 1984, etc., in tune with the demand of the times and in harmony with the aspirations of the people of India;
- To enact the Genetic Privacy Act for protection of genetic samples and for disclosure of genetic information and also to prohibit discrimination based on a person's real or perceived genetic status and to ensure that employers are not permitted to collect or use genetic information for any purpose that may be adverse to the interests of an employee;
- To ban Human reproductive cloning which should be made a criminal offence to bring the national law in tune with Article 11 of the Universal Declaration on Human Genome and Human Rights, 1997;
- To statutorily define status of human embryo so that research on embryonic cells is done under statutory control and regulations;
- To devise a mechanism to establish links with the International Community for dispute resolution of emerging issues in new biology;
- To take appropriate measures to encourage forms of training and dissemination of information regarding the fundamental issues relating to the defence of human dignity which may be raised by research in new biology and its applications;
- To create a National Reference Forum involving legal fraternity and scientists to act as an advisory body to the judiciary on matters arising out of developments in new biology;

*Report of the conference on 'Impact of new biology on justice delivery system: Issues relating to DNA fingerprinting, intellectual property rights and ethical, legal and social implications', held during 3–5 October 2003 at Hyderabad.

- 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.'

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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 $^3He/^4He$ 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). 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 CO_2-rich. High $^3He/^4He$ ratios do not imply high ^3He (as in the plume model) but low ^4He. Such ratios could develop in olivine-rich cumulates in magma chambers because olivine crystals trap ^3He and have no U–Th (and therefore no ^4He growth). Remelting of such mafic rocks would produce magmas with high $^3He/^4He$ 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 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 Dziewonski (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.