# Proper time for scientific diplomacy

The decisions by both India and Pakistan to detonate nuclear tests will almost certainly hamper communication between one group of Indians and Pakistanis who would like the chance to talk more, the scientists of both countries. It is obvious that India will not stop Muslims from Pakistan flocking to the shrines of revered Sufi saints. And Pakistan will not stop Sikhs from India crossing the border to visit their second-holiest temple. Even they will not, for example, diminish the passion Pakistanis have for Indian cinema, nor the fondness that Indians hold for Pakistani television soap operas. But the irony for those who gave their countries nuclear weapons status is that they face increased isolation not only from the whole world, but also from each other. Science is perhaps one of the few vehicles that could help raise both the quality of life and levels of trust between these two as well as other neighbouring SAARC (South Asian Association for Regional Cooperation) countries. But at present, official, bilateral, scientific cooperation does not exist.

Actually scientists from both countries are not totally isolated from each other. They meet at international venues, such as the Abdus Salam Centre for Theoretical Physics in Trieste, Italy, and at United Nations environment conventions, where both countries form part of the group of 77 developing states. Pakistan's scientists can, in theory, travel to New Delhi to visit the International Centre for Genetic Engineering and Biotechnology. Indian scientists, similarly, can travel to Islamabad to visit the headquarters of the Intergovernmental Commission on Science for Sustainable Development for the South.

But in practice, contact is rare. Scientific collaboration may have helped both much to gain between their communities, but it has become one of the casualties of the continued tense relations between India and Pakistan. Politicians from both sides view science as a key element of each country's defence and security and consider scientific cooperation, no matter how innocuous, as close to giving away state secrets. If pressed, they tend to take the view that enhanced scientific collaboration will follow progress on outstanding political issues, not vice versa.

This is unfortunate as scientific collaboration can, as the West has shown, help to ease political tensions. This type of collaboration could bring urgent practical benefits directly to help India and Pakistan, tackle a range of common problems including diseases like malaria, tuberculosis, agricultural issues (i.e. crop improvement), environment issues (i.e. air pollution), road transport and gradually the Kashmir issue.

In fact, there is much evidence that scientists from both countries would like to collaborate, but they need both permission and support from their politicians, which has so far been lacking. This support in turn needs courage, diplomacy and an enlightened view of India–Pakistan relations. If any one Prime Minister from the SAARC countries can take an initiative for scientific diplomacy through SAARC scientific cooperation, people will hopefully benefit, so what does he/she have to lose?

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## NEWS

# Active faulting and paleoseismology*

The summer school held at Institute de Luxembourg which was sponsored by the European Centre for Geodynamics and Seismology, in collaboration with Royal Observatory of Belgium, Instituto di Ricerca sulla Tettonica Recente (Italy), European Commission and European Seismological Commission, provided a forum where accomplishments and challenges in active faulting and paleoseismology could be discussed. It also offered a forum where budding researchers imbibed a few lessons on the topic from experienced workers.

*Based on a report on the Summer School in Active Faulting and Paleoseismology, Luxembourg, 10–23 July 1998.

The scope of paleoseismology is being increasingly recognized for its ability to supplement the time scale of historical and instrumental catalogues and to provide the faulting parameters necessary for seismic hazard assessment. It is the study of large or moderate-sized earthquakes and related displacements as recorded in geological units. The school provided courses in paleoseismology and presented a comprehensive panel of field studies including geomorphological, geophysical and trench investigations. Recent developments in paleoseismology with new results were provided by experts from different parts of the world. The objectives of this summer school were to provide a forum for the discussion of earthquake geology, to exchange field experience and to debate on the methodologies used in paleoseismology and their limitations. Worldwide case studies of surface ruptures, coseismic displacements and faulting behaviour were discussed. Further, the programme addressed the problem of earthquakes and their traces in the geologic record.

Scientists with diverse background in geology and geophysics attended this school with the following participation: (1) European and international experts in active faulting, paleoseismology and engineering seismology; (2) young researchers in earth sciences working on the problem of seismic and geologic

hazards; (3) postgraduate students studying active zones and (4) engineers and researchers interested in the behaviour of seismogenic faults. Four main topics were discussed: (1) Seismology and active faulting; (2) Paleoseismology, new techniques and results; (3) Uncertainties and dating methods; and (4) Faulting behaviour and implications for the seismic hazard assessment. The meeting started with the opening remarks by the Director of the Chateau-Luxembourg, a historic castle which houses Institute de Europe. Mustapha Meghraoui, the key organizer and a leading researcher in paleoseismology introduced the topic of the meeting. Later an overview talk was given by Anthony Crone from the United States Geological Survey, which served as a curtain raiser.

Classes that started on 10 July and ended on 23 July 1998, dealt with physics of the time evolution of earthquakes, repetition of earthquakes, space–time behaviour of active faults, analogue modelling of faulting processes and near field earthquake hazard from surface faulting and touched upon seismotectonics, active faulting, laboratory models of deformation and recurrence. With a large cross section of workers from various continents, discussions naturally had a wide range and often led to in-depth analyses.

The meeting included a geology tour to Ardennes Massif near the Belgium–Netherlands border to show the participants some aspects of tectonic geomorphology on 14 July 1998. Three-day-long field training on trench mapping was given at Bree fault scarp along Rhine valley. The trench exposed a suspected normal fault with liquefaction features. Along with this, morphology tour along the fault scarp was also given (incidentally, this area was very close to Waterloo, where Napoleon met the most ignominious defeat at the hands of combined British and Prussian forces in 1815). Lecturers and students actively took part in the discussion of the features exposed in the trench. Classes were given on Ground Penetrating Radar (GPR) and its applications in deciphering the subsurface faults and other features.

The overwhelming response to this initiative clearly underlines the need to expand active faulting studies. This was reflected in the last session on the final day which focused on the accomplishments and outstanding problems. Papers and discussions indicate that the methodology followed in paleoseismological studies has the potential to increase our understanding of crustal deformation along major faults. It has made major contributions to the earthquake study programmes in many countries. These studies provided insight into fundamental aspects of earthquake research which include earthquake recurrence intervals, maximum magnitudes and fault segmentation. Basically paleoseismological studies address two fundamental questions: when did the last earthquake occur and how often do earthquakes occur. Resolution of these questions is not an easy task because of their strong dependence on a time element. Advancement in the geochronological techniques and their accuracy will certainly have a bearing on the growth of paleoseismology. Aside from this, another challenge is the identification of historic earthquakes in the geologic record and estimating the magnitude of those events. In other words, one major limitation of paleoseismology is the incompleteness of geologic records, because magnitude threshold of surface faulting varies according to type of faulting, hypocentral depths and material properties of rocks. This emphasizes the importance of studying historic ruptures, thereby increasing the quality of database. With detailed geologic mapping, and a refined understanding of structural patterns and regional seismicity, we may be able to improve our ability to characterize and define seismotectonic provinces.

An important point raised in the meeting was the need to increase our resolution limits. How can it be done? One option is, of course, to systematically study the nature and extent of deformation associated with historic events in a variety of tectonic settings. Related problems are slip measurements and their conversion to magnitude of paleoearthquakes. These estimates of paleoearthquakes are obtained from regression relations of surface displacement vs magnitude or rupture length vs magnitude for historic earthquakes. Although the solution lies in improving our database by systematically studying the historical earthquakes, it should be remembered that paleoseismological studies involve rigorous analysis of different sets of data and understanding their interrelationships, with a caution not to overinterpret insufficient data. Another question raised was about fault behaviour. Some faults appear to generate earthquakes in a regular and predictable fashion whereas others seem to generate earthquakes as temporally clustered. Resolution of this aspect again requires more data which will improve probabilistic models of seismic hazards. Discussions also centred around Gutenberg–Richter frequency-magnitude model and the most often quoted $b$ value. A dominant view is that when a single fault is considered, it is the 'characteristic earthquake' model that has more relevance. This meeting in Luxembourg, known as the 'green heart of Europe', proved again that the true science can thrive only through interaction, review and continuous flow of information, breaking all the artificial barriers.

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