MEETING REPORTS

Mathematical modelling of groundwater in mining area*

The development of groundwater resources for water supply and allied civil engineering projects is of prime importance. These have received emphasis through various approaches including mathematical modelling which has been used for the solution of a variety of groundwater problems arising in understanding hydrological processes, management and forecasting. Central Mining Research Institute (CMRI), Dhanbad had organized a programme on mathematical modelling of groundwater in mining area, for the benefit of earth scientists dealing with groundwater for civil and mining engineering projects. Twenty participants from various universities, IITs, national research institutions and private sector attended the programme. Experts from different organizations spoke on various aspects of mathematical modelling of groundwater in mining areas, covering fundamental aspects of mathematical modelling of groundwater hydrology, numerical techniques and status of software, role of mathematical modelling for mining-induced problems, role of mathematical modelling for groundwater quality and case studies.

In his inaugural address, A. B. Patti (CM, MADA, Dhanbad) described how the quantity and quality-related problems of water are not only associated with mines, but also for a variety of other applications all over the country as well as in the world.

The technical sessions began with an introduction by P. K. Gupta (CMRI), who informed that Indian mining areas belong to sedimentary and hard-rock formations. The basins of Damodar, Sone, Mahanadi and Godavari rivers belong to sedimentary rock formations, which are associated with coal, limestone, bauxite mines, etc. Hard-rock provinces like Singhbhumi, Mayurbhanj, Aravalli and Dharwarian Craton are confined to metal mining. He spoke about groundwater inflow into underground and opencast mines, including the most commonly observed hydrogeological conditions. The impact of mining on local groundwater regime is limited to small distances for a temporary period. With no processing activity involved, the mine water is mostly free from serious pollutants and can be utilized for public use. Regular mine discharge into the local drainage replenishes the groundwater system and maintains water levels in the local area. During such instances, the mine water discharge becomes a resource/product rather than waste. T. N. Singh (IIT Bombay) talked about the disturbed state concepts, which provide a new and alternative approach for characterizing the geo-material behaviour and interfaces in the mines. A. P. Singh (CMRI) covered the basic concept of tracers and their applications in identification of source origin, recharge estimation, travel-time estimation, hydraulic connectivity of different aquifers, interaction of surface–groundwater systems, groundwater dating, etc. K. L. N. Rao (Bangalore University) talked on 'Estimation of aquifer parameters under unsteady and steady states'.

A. K. Rastogi (IIT Bombay) talked about finite element method, which is a numerical procedure for solving physical problems governed by differential equations. He also discussed inverse modelling, which is applied to estimate the hydrologic parameters and aquifer recharge in various sub-regions of a system with adequate reliability. R. K. Tiwary discussed some groundwater modelling software (namely Aquifer Test Pro, Visual Help, FEFLOW, FLOWPATH II, MODFLOW SURFACT, FRACTRAN, Visual MODFLOW, MT3D, etc.).

For mining-induced problems, P. Pal Roy (CMRI) spoke on 'Assessment of safety and stability of Vattivagu Irrigation Dam in AP, Southern India'. He predicted that the ground vibration with a suggested maximum charge/delay of 324 kg at a distance of 4.5 km would be 0.63 mm/s, which would not cause any damage to the Vattivagu Dam. This was followed by a lecture on 'Impact of surface blasting on underground structures, including water bodies'. He also dealt with major failures in underground mines, such as collapse of roof and failure of pillars, which would depend upon the geological condition of the mine and rock mass rating of the roof rock. M. Prasad (CMRI) described a model which gave an optimal stable horizontal crown pillar for a lead–zinc mine (Balaria mine, Udaipur, Rajasthan) under a 15 m crown pillar at 190 m reduced level (RL), which is safe and stable for future mining between 175 and 120 m RL. In another lecture, Prasad spoke on the Tista river in Sikkim, which flows just above a rich lead–zinc–copper ore body. The wider part of the ore body occurs below the riverbed. Through numerical modelling, he showed that the thickness of the barrier pillar below the riverbed could be suitably reduced from 38 to 20 m, without endangering the working of the mine. Gupta discussed the nature of groundwater fluctuation in a saturated zone associated with deformation pattern, related to subsidence in mining areas and also spoke about groundwater inflow into underground and opencast mines. This inflow rate is governed by geology, groundwater hydrology, mining parameters, etc. Gupta also dealt with dewatering in mining areas, which depends upon intensity and magnitude of water ingress, and also governing parameters like *T*-values, water level, discharge rate, rainfall, etc.

M. S. Alam (CMRI) delivered a lecture on 'Mathematical modelling for classification and delineation of groundwater quality in and around coal mining area'. M. Sundararajan (CMRI) noted that the groundwater potential factor is useful to identify groundwater potential zones in any micro-watershed of mining areas. T. N. Singh spoke about acid mine drainage, one of the alarming problems in mines, particularly in some of the coal mines, where coal contains pyretic material.

The lecture series related to case studies began with a talk on 'Water disaster in mines' by T. N. Singh (EFMA) who focused on distribution of water and inundation characteristics of mines. According to Singh, there is good groundwater potential in basaltic regions (clay formation) in India due to black cotton soil and Deccan Trap. The worst inundation disaster of Indian mining was at Chasnalla mine, IISCO located in the vicinity of a boundary fault and Damodar river. He pointed out that limestone is a good groundwater potential resource. He also discussed about the importance of tensile and com-

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pressive forces developed during mining activities. This was followed by a lecture by S. K. Chaulya (CMRI) on 'Approaches for solving groundwater problems at Khadsaliya lignite mine, Bhavnagar district, Gujarat'. The next talk was by Tiwary, who focused on the fact that Sukinda ultramafic belt of Orissa processes the largest chromite deposit of India associated with vast resources of oxide nickel ore and produces nearly 8% of chromite ore. It may be damaging nearby land and water resources. Using MODPATH, Tiwary showed that the movement of particles (pollutants) was found to be negligibly small (10 m) over a period of 20 years in the first layer and 15 m over a period of 20 years in the second layer. N. C. Mondal (NGRI, Hyderabad) gave a lecture on 'Applications of MODFLOW in the study of groundwater flow and solute transport' and also demonstrated Visual Modflow 2.6.1 taking a specific problem. According to Mondal, groundwater modelling depends upon conceptualization of the system. Gupta discussed about the groundwater problems in deep underground gold mines in South Africa. In the last lecture, Gupta dealt with a spectrum of errors categorized into source, kind and nature during handling of groundwater data for mining areas.

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B2B-2K5: The new buzz in translational research*

Translational research is simply research that results in the development of new and improved medical treatments. The theme that discoveries made at the laboratory bench can lead to the delivery of more effective care at the hospital bedside, was captured in the catchy and alliterative subtitle 'B2B-2K5' during the recently held conference. This report is a brief overview of the 30 talks delivered at this conference by some of the leading clinicians and scientists from India and the United States.

Imaging technologies leave magical impressions, as anybody who has had an X-ray, ultrasound, CT or PET scan can attest. Jason A. Koutcher (Memorial Sloan-Kettering Cancer Center, New York City) described the recent progress made in applications of magnetic resonance imaging (MRI) and magnetic resonance spectroscopic imaging (MRSI). MRI can now be used to scan the whole mouse and detect the presence of hepatic tumours. Three-dimensional ^{31}P-MRSI can be used to detect the levels of individual metabolites (e.g. nucleotide triphosphates, phosphotidyl ethanolamine) in individual 'voxels' (volume pixels) of the liver. This allows one to determine when normal metabolism is restored following surgical resection of liver cancers. This is important for the administration of adjuvant chemotherapy. If chemotherapy is given too early it can lead to killing of the regenerating liver cells, but waiting too long post-surgery can allow the tumour to re-grow and the therapy would no longer be effective. MRSI can also be used to stage prostate cancers based on the levels of citrate and choline. Citrate levels are relatively high in the normal prostate, whereas high choline is an indication of rapidly proliferating tissues such as tumours. By measuring the levels of choline and citrate in individual voxels, one can localize where a tumour might be located in the prostate. This would allow biopsy to be directed to that location, rather than taking a random biopsy sample. About 130 patients examined in this way, who subsequently underwent radical prostatomy, revealed that MRSI had a sensitivity of 85–90% for high-grade tumours. The sensitivity was not as good for lower grade tumours. The approach is not without pitfalls. For example, spectral degeneration is seen in the region of haemorrhage and conditions like prostitis can cause false positives.

Irradiated tumours can serve as a source of tumour-associated antigens. Alan Alfieri (Albert Einstein College of Medicine, New York City) described the exciting possibilities of radiation-induced autologous tumour vaccination. Local tumour radiotherapy (60 Gy) was combined with injection of the cytokine Flt3-ligand (Flt3L) in a murine model of Lewis lung carcinoma. Dendritic cells (DCs) are known to present antigen from apoptotic cells, and Flt3L is known to expand DCs *in vivo* and thus was expected to improve antigen presentation from dying, irradiated tumour cells. Alfieri *et al.*, found that radiotherapy + Flt3L reduced pulmonary metastases and significantly improved survival in C57Bl/6 mice with established footpad tumours. Mice treated with Flt3L alone showed delayed tumour growth, but eventually succumbed to tumour progression. The combination therapy of radiotherapy + Flt3L failed to work in immunodeficient athymic (nude) mice, implicating the role of T-cells in prolonging survival. Thus sequential radiation and immunotherapy with Flt3L to enhance tumour antigen presentation may produce therapeutic responses against disseminated cancer and improvement in survival. Immunotherapy was also the theme of the talk by Ashok Khar (Centre for Cellular and Molecular Biology (CCMB), Hyderabad). He described studies on the spontaneous regression of a rat histiocytoma transplanted subcutaneously in a syngenic host. The major effector of this regression was the NK cell, which induced tumour antibody-dependent tumour cell death via necrosis and apoptosis. His studies showed that immune cells (NK cells, dendritic cells and macrophages) influx into the peritoneum. The NK cells get activated and then migrate back to the tumour to cause cell death.

Radiation also holds promise for facilitating recovery from spinal cord injury in a rat model. Kalderon and Alfieri had previously demonstrated the beneficial effects of X-rays after transection injury to the nervous tissue. They had found that radiation focused on the injury site prevented the degenerative process called cavitation and thus preserved structural integrity and electrophysiological function. Chitti R. Moorthy *et al.* (New York Medical College, Valhalla) did similar investigations, but with a contusion (crush) injury to the rat spinal cord and found

*A report on the 'First Annual International Conference on Translational Research for Cancer and Other Diseases' held at the Centre for Cellular and Molecular Biology, Hyderabad during 19–20 March 2005.