

APPLIED GEOCHEMISTRY OF ENERGY RESOURCES AND PRECIOUS METALS. Special Issue of Journal of Applied Geochemistry (v.10, No.2A, July 2008). Published by Indian Society of Applied Geochemists, P. B. # 706, Osmania University, 1-2-7/1, "Roja", Kakatiyanagar, Habsiguda, Hyderabad - 500 007. Pages: iii+316p.

The Indian Society of Applied Geochemists (ISAG) has a healthy tradition of publishing proceedings of its Seminars/Symposia within one year from the event, and the present publication on Applied Geochemistry of Energy Resources and Precious Metals (Journal of Applied Geochemistry, v. 10, No.2A, July 2008; Proceedings of the National Symposium, 19-20 September 2007, Hyderabad) reflects renewed sincere effort of the Society.

The Earth Sciences, particularly geochemistry, have an important role to play not only in sustainable economic development through prospecting and exploration of natural resources including oil, natural gas, coal, radioactive minerals and precious metals needed to meet energy requirement, but also in establishing and reducing the concurrent causes of emissions and contamination. This Special Volume of the Journal of Applied Geochemistry incorporating research findings of dedicated geoscientists and academia is a testimony in conformity with the contemplated role of earth sciences. The full length papers presented at a National Symposium organized befittingly at the Atomic Minerals Directorate, Hyderabad, are meticulously compiled in a voluminous issue of the Journal of Applied Geochemistry to offer a smooth read to any interested geoscientist.

The volume consists of 25 articles on topics of hydrocarbon accumulation, petroleum geochemistry, multilayer reservoirs, hydrocarbon prediction, radioactive wastes, sandstone U deposits as analogs for geological disposal conditions, Cs migration, exploration-exploitation-energy-economy-environment (5Es') for explosive growth, Tertiary coals, geothermal energy potential, analytical methods for Au and other precious metals, pathfinder elements, mafic dykes and mantle source, marine minerals, U deposits, ground water recharge, fluoride in ground water, defluoridation by fly ash, groundwater quality, bioremediation, minimization of metal pollution, environmental impact of Fe ore mining, and mining environment. The proceedings volume has a balanced distribution of papers on the relevant topics. There are five articles each on energy resources, environmental geochemistry and ground water quality, *four* on radioactive metals, *two* on precious metals, *one each* on coal, geothermal energy, igneous geochemistry and marine minerals.

In the first article entitled 'India's energy security through efficient management of resources' Jokhan Ram points out that with the BRIC countries (Brazil, Russia, India and China) attaining high growth rate (particularly India and China on the threshold of a 10%), the demand for energy

has suddenly increased. India's dependence on fossil fuels would increase from 68% to 78% by 2032. He presents very lucidly the scenario of various energy sources in India including the conventional oil and coal, and unconventional energy sources including coal-bed methane (CBM), tight gas in ultra-low permeability rocks, gas in ultra-low permeability shales, basin-centred gas and gas hydrates and alternate sources of energy including bio-fuels and nuclear energy and further, the various initiatives taken up by ONGC. He stresses the need for assurance of energy security by achieving self-reliance through increased indigenous production; investment in equity oil abroad should be one of the key policy objectives. It is evident that ONGC nurtures a vision of 'energy solution provider' ensuring energy independence to the country through its renewed efforts in this direction.

The second paper is on 'Hydrocarbon accumulation in Miocene sequences –a case study of Ahmedabad block, Cambay basin' by Trilok Chand *et al.* It is an attempt to systematically evaluate mode of accumulation, paths of migration and regional quality of the hydrocarbons. The hydrocarbon accumulation is identified by rock-Eval and GC data on 832 samples from 37 wells. Genetic correlations have revealed that the area bounded by Wasna-A, Kalol-Q, Nawagam-U, and Sanand-R is promising for Miocene hydrocarbon accumulation. This paper has a location map, fingerprint illustrations for the presence (or otherwise) and migration of hydrocarbons and a map showing promising areas for Miocene oil.

The third contribution is on 'Petroleum geochemistry of oils and condensates of Kesanpalli west field, Krishna-Godavari basin, India' by Rawat *et al.* A new play in the Tertiary Vedaparur shale-Matsyapuri sandstone petroleum system is identified by regional sedimentation modeling. The geological horizons have abundant aliphatic hydrocarbons in oil and condensates. A significant outcome of this geochemical study is that the investigated field hosts two oil families -Group I condensates with higher oleanane and $(C_{29}/C_{30})_{\text{hopane}}$ but lower pristane/phytane (Pr/Ph) ratios, and Group II with lower oleanane and higher $(C_{29}/C_{30})_{\text{hopane}}$ but higher (Pr/Ph) ratios. This paper offers an impressive location map, generalized stratigraphy, quality geochemical data and convincing illustrations.

The fourth paper entitled 'Episodic filling of multilayer reservoirs of Gandhar field, south Cambay basin, India' is contributed by Saxena *et al.* Chemical analysis of Gandhar oils for carbon isotopes, biomarker composition including Pr/Ph, isoprenoid / n-alkane, sterane and terpane ratios in addition to bulk other parameters, has revealed four distinct groups of oils. : Group A, B, C and D. Geochemical modeling

of origin, migration and accumulation of hydrocarbon suggests multiple charge process for oils to fill each reservoir over long duration. This interesting contribution presents a good stratigraphy, structural blocks, a cross section of south Cambay basin showing geographic and stratigraphic extent of the Cambay Hazard petroleum system, mass chromatograms of oils, hopane and sterane, and binary diagrams illustrating chemical variability in the samples.

The fifth paper on the 'Application of adsorbed gas analysis technique for prediction of hydrocarbon signature in Dehradun re-entrant area of Himalayan foot hills' by Singh *et al.* is an attempt to identify the possible sources of hydrocarbon seeps in the study area and to correlate them with structure maps for better understanding of hydrocarbon potential in the Dehradun re-entrant. No oil or gas reservoir is perfectly impervious and no hydrocarbon seepage is imperviously perfect. The dynamics of oil seepage can vary from passive through active (and visible) to inactive (and detectable analytically). Out of several methods acclaimed for detecting geochemical anomalies 'adsorbed gas analysis method' is widely used for hydrocarbon exploration. This valuable contribution has a colourful geological map of Doon valley and convincing illustrations (superimposing anomalies and isochrones) for different locales on the Dharmasala formation.

The sixth paper is centered around the "Studies on long term leaching behaviour of vitrified waste product containing sulphate bearing high level radioactive waste" by Vidya Tharat *et al.* A large amount of radioactivity in nuclear fuel cycle is concentrated in 'high level (radioactive) waste' (HLW); for example, sulphate-bearing HLW is generated during reprocessing of spent fuel from research reactors at BARC, Trombay. A barium borosilicate based glass matrix is developed for vitrification of sulphate bearing HLW. Chemical durability of waste form is evaluated by studying the leaching behaviour of the conditioned product. This paper reports the results of leaching studies of glass products made with chemically simulated waste, mechanism of leaching and alteration layer formed on the leached surface of the glass products. The paper has impressive illustrations.

The seventh contribution is about 'Sandstone U deposits of Meghalaya : Natural analogs for radioactive nuclide migration and backfill material in geological repository for high level radioactive waste disposal' by Bajpai and Narayan. Long-lived and heat emitting nuclear wastes are disposed in deep pits in suitable rocks. Despite arranging protective layers, leakage is inevitable and the situation demands search for suitable natural analog to understand insights of this leakage. The paper highlights this study as a

possibility of utilization of lean ore (discarded during mining and milling), as backfill material in far off field areas and optimizing near field buffers/backfills in a geological repository located in granitic rocks at depths from 400 to 500 m.

The eighth contribution deals with 'Role of earth sciences in deep geological disposal of radioactive wastes' by Bajpai and Narayanan. One of the prime concerns in any nuclear power programme is the safe disposal of radioactive waste. The radioactive wastes are to be isolated from biosphere for tens of thousands of years to allow their radioactivity to decay to a level of insignificant threat to mankind and environment. This informative paper presents the concept and aims of deep geological disposal, site selection, identification of suitable geological environment, Indian deep geological repository programme, laboratory based studies, conceptual design of Indian geological repository, underground research laboratories, Indian generic URL at Kolar gold mine, natural analogs and cost of deep geological disposal. In conclusion, the authors stress the need for academically trained manpower to nuclear industry to manage the disposal problem.

The ninth article is on 'Use of natural and archaeological analogs to validate long-term behaviour of HLW glass in geological disposal conditions' by Gin et al. Old basaltic and Roman glasses are studied to validate predictive models developed for assessing long-term behaviour of nuclear glass in geological repository conditions. Investigations on basaltic glass suggest that its mode of alteration and kinetics of reactions are same as those of nuclear glass. The study of Roman glass blocks altered during 1800 years in a marine environment gives new insight on the basic mechanisms involved in confined media. It is a good contribution with provisional conclusions.

The tenth contribution is on 'Synthesis, characterization and role of magnetite in Cs migration in environment: effect of humic acid' by Singh et al. The results of this study as presented in six binary diagrams, shows that sorption of ^{137}Cs on colloidal sized magnetite particles is governed by electrostatic factors and humic acid has insignificant role to play in the sorption process.

The eleventh contribution entitled 'Exploration, exploitation, energy, economics and environment (five Es) for explosive growth' by Rao narrates certain aspects pertaining to the Singareni Collieries Company Limited (SCCL). They are: integrated coal resource information system (ICRIS), mining activity, utility of coal bed methane, methods of underground coal gasification (UCG), care taken for environmental issues, and initiatives for interaction of SCCL with institutes. The Singareni coal reserves of all

categories (including proved, indicated and inferred) are of the order of 17714.46 million tonnes.

The geochemistry of the Tertiary coals from overthrust zones of the belt Schuppen, Assam, is presented in the twelfth contribution entitled 'Geochemistry of some Tertiary coals occurring in Dilli area, Sivasagar District, Assam' by Lahkar and Das. The coals of the study area are dark grey, soft, friable, non-caking to weakly caking, medium grade, low-ash, low-moisture, high-volatile and bituminous type. These matured coals with high organic sulphur are formed in a marine-influenced deltaic or lagoonal environment after a brief transport of plant debris.

The thirteenth paper deals with 'Geochemistry of geothermal energy resources and their potential in India' by Razdan. Geothermal energy is the vast reservoir of heat energy in the earth's interior, whose surface manifestations are volcanoes, fumaroles, geysers, steaming grounds and hot springs. Each geothermal system has its own structural set up, hydrological, geochemical, and enthalpy characteristics. On the basis of the enthalpy characteristics the geothermal systems in India are classified into medium (100-200°C) and low enthalpy (<100°C) geothermal energy resource systems. The paper highlights with a general assessment of Indian geothermal energy resources. There is an impressive colorful geological map of India showing Indian geothermal resources.

In the fourteenth paper, Balaram discusses various 'Analytical methods for gold and other precious metals in exploration studies' and their suitability to generate data rapidly. It is concluded that a combination of (a) cyanidation method, (b) aqua-regia treatment, and (c) aqua-bromine method of dissolution with AAS and ICP-MS is ideal especially for large set of samples. There are very informative (14) Tables presenting valuable data related to 'analytical evaluation' of gold and precious metals.

The fifteenth paper is on 'Role of path-finder elements in gold exploration -case studies: Chikkasiddavanahalli area, Chitradurga schist belt, western Dharwar craton, Karnataka, India' by Sunder Raju. An attempt has been made in this paper to understand the nature of gold mineralization in the study area. A geological map and four geochemical correlation diagrams highlight the results of the study.

The sixteenth paper is on 'Geochemistry of the mafic dykes of the basaltic terrain of the Deccan volcanic province (DVP) in the Amba Dongar region, Gujarat: some petrogenetic aspects and reflection on the mantle sources regions' by Subba Rao et al. The paper incorporates good major and trace elemental data including REE on 18 samples illustrated in five variation diagrams. The results suggest that the plume related liquids are parental to the dykes in

the study area. The paper is crisp, the data is valuable and illustrations are pertinent.

The seventeenth paper is about 'New trends in exploration for marine minerals' by Roonwal. The paper highlights the formation, nature and exploration methods of marine minerals such as manganese nodules and volcanogenic hydrothermal massive sulfides.

The eighteenth contribution is on 'Spatial and temporal variability of hydrogeochemical patterns around Wakhyn uranium deposit, Meghalaya' by Dhurandhar et al. Imaging of hydrogeochemical data and dissolved mineral species reveal spatial and temporal variation in relation to environmental chemistry. The paper presents a colourful geological map of Wakhyn area, geochemical data and a few relevant parameters on surface water samples, various Piper diagrams showing hydrochemical facies, maps for individual elements, saturation index images and other chemical diagrams.

The nineteenth paper is a 'Geochemical study of groundwater recharge using ^3H as a tracer at NSDF, Trombay' by Yadav and Joshi. Among several methods to estimate ground water recharge, 'tritium (^3H) tracer method' is advantageous because ^3H moves ideally with water flow, it's non-sorption by soil, less toxicity, high degree of accuracy in instrumental measurement as shown in the present study of Near Surface Waste Disposal Facility (NSDF), Trombay.

The twentieth paper is on the 'Occurrence of high concentration of fluoride and it's genesis in ground water in eastern part of Karbi Anglong District, Assam, India' by Rao et al. Fluoride concentrations in deep-seated groundwater samples reach 20.6 mg/l while in samples from a thermal spring is 8.7 mg/l. The paper presents a good geological and structural map and hydrochemical data as illustrated and interpreted with meaningful conclusions.

The twenty-first contribution is 'A preliminary report on defluoridization using weathered fly-ash' by Surya Prakash Rao et al. The paper reviews various defluoridization techniques (removal of water fluoride in excess of 1.5 mg/l) including Nalgonda technique, activated alumina process, ion exchange, bone-char, reverse osmosis and electro-coagulation. The paper presents a new method of defluoridization Sivannagudem waters by addition fly ash to the samples. The method has advantages of high defluoridization capacity, low capital investment and operational cost, material (fly-ash) availability, and ready to use characters. However, a concurrent increase in the alkalinity of the waters during the process of defluoridization could be encountered by providing sufficient aeration.

The twenty-second paper is on 'Groundwater quality in

Puri town, India – a case study' by Srivastav et al. A systematic study on 130 groundwater samples reveal that NO_3^- and PO_4^{3-} are the main contaminants while some sample have even bacteria. The soak-pit type of sewage disposal system in the residential colonies to the N and NW of the Jagannath temple is the probable source of contamination. The paper incorporates characteristics, relative concentration of major cations, quality and seasonal variations of the parameters of Puri waters.

The twenty-third paper entitled 'Bioremediation techniques to minimize toxic metal pollution' by Kariyanna, mainly records pollution prevention methods through plants, plant products and microbes.

Under the section 'News and Views' of this Special issue, there are two contributions. The first paper is on the 'The environmental impact of iron ore mining in the Sandur-Hospet-Bellary belt, Karnataka' by Prabhakar et al. The paper presents ambient air quality measurements during May 2008 in the mining area. The paper is an eye opener with a scenario of the most extensively mined iron ore belts of Karnataka depicting severe impact caused on the local community and the environment. Several viable remedial measures have been suggested to improve the prevailing situation and to ensure a sustainable mining activity. It is a very important and interesting paper on the environmental hazard caused by mining. The second paper under this section is on 'Mining and environment: challenges and opportunities in Rashtriya Ispat Nigam Limited (RINL)/ Visakhapatnam steel plant (VSP), Andhra Pradesh, India' by Mishra and Kasipathi. The challenges and opportunities for the proposed expansion of the steel plant are presented.

The reader of this special issue will surely be benefited by the rich data available on various aspects of energy resources and precious metals. This publication is a precious addition to any individual's personal collection, and it should be owned by all libraries of Earth Science departments in the academic institutions, and professional organizations for general reference by students, teachers, researchers and professional geologists. The publication is available at the Indian Society of Applied Geochemists, P. B. # 706, Osmania University, 1-2-7/1, "Roja", Kakatiyanagar, Habsiguda, Hyderabad-500 007. Emails : isag1993@yahoo.co.in and ksprao1939@yahoo.co.in.

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