

Conference Report

International Conference CSCOP-TSOP 2002- Emerging Concepts in Organic Petrology and Geochemistry, Canada [including Dr Archie G. Douglas Symposium]

31 August-4 September, 2002

The Banff Centre, Banff, Alberta, Canada

The conference was held at The Banff Centre, Banff (near Calgary), Alberta, Canada during August 31st to September 4th, 2002 under the Chairmanship of Dr Martin G. Fowler, an eminent Organic Geochemist of Geological Survey of Canada, Calgary. This event was a part of the on-going series of annual meetings held by The Society for Organic Petrology (TSOP) and was organised and hosted by The Canadian Society for Coal Science and Organic Petrology (CSCOP) under the Secretarial control of the Elsevier Science (The Netherlands). The conference was sponsored by Elsevier Science and the European Association of Organic Geochemists. The conference was also co-sponsored by— CDX Canada Company, Integrated Geochemical Interpretation Limited, Canadian Forest Oil, Zeiss Company, JP Petrographics, Natural Resources Canada (Geological Survey Calgary), Petrologic Services- Coalbed Methane Geology, Suncor Energy, SUNOCO- a Suncor Energy Company, and Fording Coal Limited.

Over 150 delegates attended the CSCOP-TSOP conference from 25 countries of six continents— Australia, Austria, Brazil, Canada, China, Croatia, Czech Republic, Denmark, France, Germany, Greece, India, Italy, Japan, Kuwait, Lithuania, New Zealand, Nigeria, Norway, Saudi Arabia, Taiwan, Thailand, The Netherlands, United Kingdom, and United States of America, representing a variety of academic, industrial and governmental institutions reflecting the breadth of scientific community. The overall activities and arrangements of the conference were excellent.

Saturday, August 31st was specified for registration and pre-conference workshop/short course on the topic “A prediction of total organic carbon contents and hydrogen indices in marine sediments” conducted by Dr Richard V. Tyson, University of Newcastle upon Tyne, UK. About 32 candidates (including one of us- BDS) from different countries attended the course. This one-day course was focused on the numerical prediction of the two most fundamental petroleum source rock parameters—Total Organic Carbon (TOC) and Hydrogen Index (HI). The course reviewed the main fundamental controls on the organic content of marine sediments- organic matter input (carbon fluxes), organic matter preservation and sediment dilution, and showed how these parameters interact to produce a given TOC. It was also described how marine sediment data have been used to

understand these relationships and to define empirical correlations that can be used to predict TOC in unknown situations.

The prediction of HI was approached in two different ways: from versus TOC trends, and from the modelling of palynofacies (or organic petrological) data. It was also showed that how improved HI predictions can be obtained using total fluorescence preservation scale to assess the variable preservation state of the marine organic matter, and also by modelling lateral variations in the supply of terrestrial organic matter. Course delivery was mainly in the form of lectures, but some practical exercises were also included (example calculations). There was also a demonstration of TOC and prediction spread-sheets developed by course tutor. The course was informative and educative and got participants well-versed with the methodology.

The scientific presentations began on Monday, September 2nd with address by the Chairperson of the conference—Dr M.G. Fowler. The Elsevier Science published an abstract volume containing 110 abstracts of scientific papers. Altogether 68 contributed papers were selected for oral presentation (including 11 for *Dr Archie G. Douglas Symposium*) under following six themes:

1. Shallow Thinking

(Papers related to— Recent sediments, peats, weathering, palaeo-archaeology, Ocean-drilling program, environmental applications of organic geochemistry and organic petrology, C-N-S cycles)

2. Solid Bitumen and Pyrobitumen

(Papers related to— Alteration by biodegradation and thermochemical sulphate reduction, organic-inorganic interactions, physical and chemical properties and evolution)

3. Sources (and sinks) of Natural Gas

(Papers related to— Coal bed methane, CO₂ sequestration, non-marine and marine kerogen, coal and bitumen origins for gas)

4. Novel Analytical Approaches

(Papers related to— Confocal laser scanning microscopy, CSIA, thermo-gravimetric-gas chromatographic analysis, modelling, organo-stratigraphy and hydrocarbon fluid inclusions)

5. Petroleum Systems

(Papers related to— Characterisation of migration pathways, organic geochemical and organic petrological analysis of the source, carrier and reservoir system)

6. Coal and Environment

(Papers related to— Trace elements, coal petrography, coals as source rocks, green house gases)

Two parallel sessions for oral presentation were organised on September 2nd and 4th. A symposium (on September 3rd) was also included in honour of Dr Archie G. Douglas for celebrating years of Organic Geochemistry. "Treibs Award-2002" was awarded to him for his service in the field of Organic Geochemistry, as both scientist and a mentor.

Besides the symposium, we attended selected papers of sessions related to our own research interest as well as modern trends of research. Some of the important papers presented under different sessions were focussed on Natural gas hydrates, Organic petrology and Organic geochemistry, Oil biodegradation, Sequence stratigraphy, Chemotaxonomy and Spectroscopy.

Besides 40 posters were displayed dealing with Coal depositional environments, Fluorescence Microscopy, Microfacies analysis, Heavy metals and CBM and Plant (OM) degradation.

Major Results Reported

CE Barker (USA), RM Bustin (Canada) and JC Clough (USA) explained *Significant methane storage capacity in solid bitumen* and opined that a metamorphosed oil reservoir can contribute significant quantities of shale gas (in Alaska) and make for an excellent drilling target. Bustin and Barker also presented "*Experimental and field evidence for formation of methane hydrates (Clathrates) in coal*" based on high pressure methane sorption isotherm analysis of coal of varying rank and moisture content at temperature as low as 0°C. This shows that at least part of the coal moisture is available to form clathrates. P.K. Mukhopadhyay and his co-workers of Canada while evaluating the "*Coal bed methane and natural gas potential in Carboniferous coal basins from Nova Scotia*" suggested that the permeability and porosity is partially dependent on coal composition and maturity but is primarily related to the structural stress.

B Cramer, P Gerling and E Faber of Germany presented "*A general model for generation and stable carbon isotope characteristics of natural gas from humic source rocks*" based on dry, open-system, temperature programmed pyrolysis experiments, on-line coupled to a combined gas chromatograph-isotope ratio mass spectrometer, performed on a variety of low mature sediments containing humic organic matter (including coals), differing in geological age, palaeogeography and maceral composition. PD Jenden (Canada) and Y Tang (USA) in their paper "*Carbon isotope geochemistry and the distribution of Devonian oil and gas reserves, western Canada*" derived the first relationships between in-place oil and gas volumes and carbon isotopic compositions of thermogenic C₁ – C₃ hydrocarbon gases.

TI Eglington and his associates of USA demonstrated "*New techniques for the characterisation of products from pyrolysis of complex sedimentary macromolecules*" by developing two approaches—(i) involves the coupling of flash

(Curie point) pyrolysis with comprehensive two-dimensional gas chromatography (GCxGC) and time-of-flight mass spectrometry (TOF-MS), and (ii) involves the isotopic characterisation of individual pyrolysis products. MM Cross of UK and his associates reported "*Experimental determination of thermochemical sulphate reduction (TSR) reaction kinetics and mechanism*" and concluded that the kinetic data and reaction mechanisms determined are generic and therefore have application in a range of geological settings. GL Couloume and his co-workers of Canada reported "*Compound specific hydrogen isotope analysis: new insights into hydrocarbon reaction mechanism and biodegradation*" illustrated with two examples of applications.

LD Stasiuk of Canada illustrated the practical advantages of using "*Laser scanning fluorescence microscopy*" in organic petrology, and presented results conducted on a suit of samples including Precambrian, Ordovician and Devonian potential source and carrier bed rocks and coals. M Hawke (Canada) and J Dehmer (Spain) while reviewing "*Are maceral ratios reliable predictors of coal depositional environments?*" stressed that the existing concept of maceral ratios needs to be re-examined.

KA Kvenvolden of US Geological Survey, California while reviewing the "*Natural gas hydrate*" concluded that even if the magnitude of the gas-hydrate-carbon (an alternative energy resource) reservoir has been over-estimated by as much as an order of magnitude, it still constitutes a major sink and source of organic carbon in the geosphere.

The facts established through paper (*Fluorescing macerals— an update* by BK Misra & BD Singh) about Indian coals (Permian, Lower Palaeocene and Oligocene) and lignites (Lower Eocene and Miocene) are—(i) the increase in the liptinite/sporinite content, in Permian coals, normally coincides with the increase in mineral matter content. This finding led to the recognition of semi-cannel or cannel coal bands in the dull bands, (ii) the resinite present in coals and lignites are of certain distinctive types, (iii) the alginite maceral (*Botryococcus*, lamalginite, etc.) also contributes in coal/lignite formation, (iv) degraded resinite, algal matter and bacterial biomass are responsible for the formation of perhydrous vitrinite/huminite, and (v) in Gondwana coals, a certain fraction of semifusinite maceral is of fluorescing type. Highly experienced organic petrologists and geochemists present stressed the need of total organic content (TOC) analysis through geochemical methods for source rock potential for light hydrocarbons, especially of Indian Gondwana coals.

AK Varma, P. Singh and AK Singh while evaluating "*Petrographic conditions for CBM of East Bokaro and North Karanpura coalfields, India*" found relationship between fuel ratio and total gas content. Estimated methane content (Kim's equation) shows correlation with vitrinite/inertinite + mineral matter. The telinite content exhibits inverse correlation with gas generated. They opined that total gas

content of the coal seams is not entirely controlled by the volume of methane generated. The desorbed gas content shows very good correlation with total gas content and with residual gas content. *In situ* estimated gas content through Kim's equation also indicates very good correlation with total gas content. *In situ* methane content appears to depend on maceral vitrinite content. They emphasised that more research work should be carried out on these coalfields for coal bed methane exploration.

Four field trips for the CSCOP-TSOP 2002 conference—(1) Upper Cretaceous Geology near Drumheller and the Tyrrell Museum of Paleontology, (2) Day hike to the Burgess Shale (Cambrian), a UNESCO World Heritage Site, (3) Sightseeing tour of the Banff to Lake Louise Area, and (4) Rocky Mountain Geology, hydrocarbon source rocks and coal, were arranged to cover a broad spectrum of geological features and scenery of the Rocky mountains, foot-hills and plains regions of western Canada. In the world renowned Royal Tyrrell Museum, history of life has been charted from its' genesis, some 3.5 billion yrs. ago, through recent times with displays from many of the rich fossil localities of western Canada.

Impact of the Conference

Participation was an excellent opportunity to interact and exchange the ideas with the scientific community dealing with Organic Petrology and Organic Geochemistry at international level. This meeting of the Society of Organic Petrology was the best scientific gathering, from almost all coal and petroleum producing countries, which covered current trends of studying organic constituents within organic-enriched recent sediments and ancient hydrocarbon source, reservoir rocks and coals. Important discussions on different aspects delivered by renowned organic petrologists and geochemists and the interaction and exchange of views, especially on various methodologies in optical microscopy and geochemical techniques, with the specialists were of immense benefit regarding the current concepts and modern techniques.

The significant feature of the conference was the special attention to modern researches and views in the field of organic-rich (coal/petroleum) sequences. Combined studies of organic geochemistry and organic petrology was emphasised and recommended. This covered wide range of interesting topics that show how both the studies can be applied to answer questions on topics as diverse as the origin of natural gas and petroleum, the impact of coal utilisation on health, microbial alteration of petroleum and the impact of climate and environment on the deposition of organic-rich sediments.

Coals are considered as good source rocks for petroleum and natural gas resources all over the world. The scope of coal biopetrology/organic petrology gained importance only recently in developed countries for exploration of oil and natural

gas and coal bed methane because of being relatively inexpensive and less time consuming and result-wise quite acceptable. In the case of microscopic study, under fluorescence mode has been found to be very reliable in categorising and quantification of hydrogen-rich coal micro constituents in comparison to that under normal incident light.

Therefore combining the two modes of studies, economic suitability of coals/lignites, preparation and beneficiation properties and prospects of coal bed methane can be suggested in a better manner. Similarly, estimation of kerogen- organic matter dispersed in sedimentary rocks in terms of nature, type and maturity utilising both modes of studies, provides very good results for oil and natural gas prospects in sedimentary sequences. Several coal and oil companies/institutions in developed countries are utilising this kind of study effectively. For coal, to act as a source rock for petroleum two separate criteria must be met. The coal must be capable of—(1) generating hydrocarbon in response to thermal stress (catagenesis), and (2) release these hydrocarbons to a porous migration conduit or reservoir (expulsion or primary migration), with the bitumen saturation threshold as 30 kg hydrocarbon/tonne of coal, noting that inertinite falls well below, vitrinite up to and liptinite exceeds this level.

In fact no ideal technique exists for evaluation of petroleum generation potential combining detailed organic petrological analyses with organic geochemical analyses can be used to constrain the limitations on both sets of techniques, leading to more robust petroleum generation models. In addition, these types of studies could allow prediction of source potential and kinetics parameters for various organic facies identified by organic petrology. Thus, taken together a more secure interpretation can be made concerning maturation, generation and expulsion of oil and gas. The combined use of organic geochemical and stable isotope data as proxies for palaeoecology and climatic changes during earth's history is receiving increasing attention.

In India, this branch of science, with multidisciplinary approach, has not received its due importance yet. Advancements made in the field of applied Organic Petrology and Organic Geochemistry (for oil and natural gas exploration and coal bed methane) should be utilised in the national interest of fuel science. More and more scientists should be encouraged and opportunity should be provided to attend such international conferences in order to understand the recent trends in researches and technologies at global level.

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