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Variation of Rivers and Their Paleo-drainages in Mesozoic Foreland Basins of North America

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ABSTRACT:

The source-to-sink (S2S) concept is focused on quantification of the various components of siliciclastic sedimentary systems from initial source sediment production areas, through the dispersal system, to deposition within a number of potential ultimate sedimentary sinks, and has more recently been applied to deep-time stratigraphic systems. In this paper the techniques for estimation of water and sediment paleodischarge and paleo-drainage area are outlined, and sediment budgets are calculated for a number of Mesozoic systems, primarily from western North America. Extensive outcrop and subsurface data allow the largest trunk rivers to be identified, typically within incised valleys. Thickness, grain size, and sedimentary structures can be used to infer slope and flow velocities, and using width estimations, water and sediment paleodischarge can be calculated. River paleoslope can also be independently measured from stratigraphic-geometric considerations and used to assess paleo-river flow. Paleodischarge in turn is used to estimate the size of the catchment source area. Paleodischarge of rivers can also be estimated independently by integrating estimates of catchment source area, for example by using detrital zircons integrated with paleoclimate.

The catchment areas of North America evolved significantly during the late Mesozoic. During the Jurassic-Early Cretaceous, fluvial systems consisting of continental-scale low slope (S=10^-4), axially drained rivers, formed the 40-m-deep channels in the Mannville Group in Canada, which now host the supergiant heavy-oil-sands reserves. During times of maximum transgression of the Cretaceous Seaway, such as the Turonian and Campanian the western North American foreland basin was characterized by smaller-scale (typically 10-m deep), steeper gradient (S=10^-3) sand and gravel bedload rivers, dominated by transverse drainages in the rising Cordillera. This created a number of smaller river-delta S2S systems along the coast, such as the Dunvegan, Ferron, Frontier, Lance and Cardium formations. As the Laramide Orogeny progressed, the Western Interior Seaway receded, and by the Paleocene the modern continental-scale drainage of North America was largely established with a major continental divide separating south-flowing Mississippi drainages that fed into the Gulf of Mexico, from north-flowing systems that drained into the Artic Ocean or Hudson's Bay, Canada.

The integration of paleodischarge estimates with provenance analysis enables improved use of the sedimentary record to make estimates about the entire S2S system, as opposed to primarily the depositional component. Clinothem stacking relationships and isopach mapping of stratigraphic volumes have also been integrated with chronostratigraphic data to analyze long-term S2S sediment budgets. A more quantitative approach to estimating the scale of erosional, transport and depositional components of

sedimentary systems, especially in the context of linked source and depositional areas, also puts constraints on the size and scale of potential hydrocarbon reservoirs and thus has economic value.

Speaker Biography:

Dr. Janok P. Bhattacharya is the Susan Cunningham Research Chair in Geology in the School of Geography and Earth Sciences at McMaster University, Hamilton, Ontario, Canada. His main research interests are in the areas of fluvio- deltaic sedimentology and sequence stratigraphy. He received his B.Sc. in 1981 from Memorial University of Newfoundland, Canada. He worked at ESSO Resources Calgary, before completing his Ph.D. in 1989 from McMaster University. Following a post-doc at the Alberta Geological Survey, Janok worked for ARCO Exploration and Production Technology in Plano, Texas, the University of Texas at Austin, the University of Texas at Dallas, and the University of Houston. He is an American Association of Petroleum Geologists (AAPG) Grover Murray Distinguished Educator, Gulf Coast Association of Geological Societies (GCAGS) Outstanding Educator, AAPG Distinguished Lecturer, and AAPG SW Section Distinguished Educator. He has been awarded the 2004 AAPG Certificate of Merit, the 2004 Dallas Geological Society Professional Service Award, the 2004 Canadian Society of Petroleum Geologists (CSPG) Best Oral Presentation award, the 2002 Frank Kottlowski Memorial Presentation Award, the 2002 Houston Geological Society Best Oral Paper Award, and the 2001 AAPG "Al" Cox Award for best poster. Janok has served as the Society of Sedimentary geology (SEPM) Sedimentology Councilor (2011-2013), Gulf Coast Section of SEPM (GCSSEPM) President (2008), and has served on various AAPG committees including the 2011 AAPG/SEPM Theme Chair, 2008 SEPM Convention Vice Chair, 2004 Technical program chair, and 1999 SEPM Field Trip Chair. He is an associate editor for the Journal of Sedimentary Research and AAPG Bulletin. Janok is now serving as President of SEPM (2015-2016). He has authored or co-authored over 125 abstracts and over 70 technical papers.

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