

Sedimentation and Tectonics in Alluvial Basins

Edited by A.D. Miall

Geological Association of Canada

Special Paper No. 23, 272 p., 1981

Members \$22.00; Non-members \$26.00

Reviewed by F.W. Chandler

Geological Survey of Canada

601 Booth St.

Ottawa, Ontario K1A 0E8

This book reflects a revival of interest in the relation between tectonics and sedimentation brought about by the advent of the plate tectonic theory. It will be of significant use to students of clastic sedimentology, to sedimentologists working in regional tectonics and to coal-exploration geologists.

The book records a symposium on molasse and related sediments held by the Geological Association of Canada in Halifax, Nova Scotia in 1980. It contains two introductory papers followed by seven reviews of the geology of actual alluvial basins. The introductory paper by Miall, the editor, explores the possibility that the tectonic setting of a clastic wedge may be derived from its facies, paleocurrent pattern and basin geometry. Two conclusions are drawn: that alluvial fans and braided rivers are likely in wrench fault and intramontane basins and in pre-drift grabens, and that major rivers and deltas are typical of divergent plate margins. However, Miall stresses the difficulty of generalizing and feels that as a rule correlation is poor. It seems to the reviewer that a fruitful alternative approach, one employed by several authors in this book, e.g., Eisbacher, is to examine the contents of the basin as a reflection of source areas and to stress the basin's place in the surrounding regional geology. The second introductory paper, by Van Houten, reviews succinctly the evolution of the term "molasse" including its use as a late-post orogenic tectofacies. With his concise and quantitative summary he sets up the Tertiary molasse of the Alpine type area as a reference standard.

Seven reviews of alluvial basins provide much useful sedimentological information as well as several good summaries of regional geology. Six of the seven feature late Devonian to Tertiary clastic wedges shed from North American orogens, one of the attributes of molasse *sensu stricto*. The exception is by Miall (see below). The contribution by Rust contrasts two alluvial sequences from the Canadian Maritimes. One, a widespread Devonian upward-fining alluvial succession, formed on a broad uniform paleoslope. The other, comprised

of Carboniferous alluvial fan conglomerates, showed local facies variation. The contrast between these two sequences illustrates Miall's first conclusion (above) as well as showing that local field sedimentology can be used to infer a fundamental change in the tectonic regime of an orogen, in this case from sedimentation in a South-Andean type retroarc basin to the formation of basins by wrench faulting that resulted from a continent's overriding of a transform fault system. Fraïck and Schenk interpret two varied and distinct upward-fining, mainly alluvial sequences in the Carboniferous Stellarton and Merigomish sub-basins of the Fundy Basin of Maritime Canada in terms of wrench faulting that released the compression of the Acadian and Variscan continental collisions. Perhaps omissions during preparation of the manuscript have obscured the meaning of the second paragraph of their summary.

Donaldson and Schumacher give a lucid and informative account of the evolution of the late Paleozoic foreland basin molasse of the central Appalachians of the United States. An early fluvio-deltaic complex prograded southwest as a result of the Caledonian-Acadian Orogeny further north. A later complex prograded northwest due to uplift related to the Alleghenian Orogeny that occurred to the south of the area. Siting of depocentres was influenced also by basement tectonics. Eisbacher uses sedimentary and structural studies with tight radiometric control to unravel the complicated history of the Late Jurassic to Paleogene Bowser Basin intramontane molasse of the Canadian Cordillera. Closing and sinking of a marginal ocean basin behind an accreting remnant island arc led to its being covered by molasse from sources including the arc, the oceanic crust of the marginal basin and, later, from metamorphosed continental terrace. Finally, cannibalization of the early molasse and marked restriction of the basin accompanied wrench faulting.

Long presents a clear and detailed account of the sedimentary facies of Tertiary wrench-fault initiated intramontane limnic coal basins of the same region. Basin shape, climate and sediment supply were major variables in determining sedimentary facies, including coal. From Nilsen comes the first detailed account of two upper Devonian-lower Mississippian redbed sequences of the Brooks Range of Alaska, a mountain chain the tectonics of which is little understood. The earlier, allochthonous, sequence was derived from the northeast but apparently thrust back later to the north, a relation between sedimentary and tectonic transport directions unlike that of the type molasse of the Alps.

Miall, in his account of the Eureka Sound Formation of the Canadian arctic islands,

brings much useful information to bear on the controversial tectonics of the region. He shows how the jostling of rifting plates during the late Cretaceous-Paleogene opening of part of the north Atlantic faulted and arched the craton. This divided the Sverdrup Basin into several sub-basins which received alluvial debris from intervening arches.

Coal geology is touched upon in five of the regional papers. In maritime Canada Fraïck and Schenk describe the geology of the Stellarton Formation and the Pictou Group, both coal-bearing units. Donaldson and Schumacher point out that in the central Appalachians major coal basins are associated with delta-plain facies. From the Canadian Cordillera Eisbacher mentions paralic coal swamps in the upper part of the Bowser Lake Group, and Long brings out the association of coal with shallow lakes and the distal facies of fans. Finally, Miall relates formation of the best coal in the arctic Eureka Sound Formation to delta-top facies.

Although the economic relevance of this book is established by the papers dealing with coal sedimentology, it would have been enhanced by even one paper on the other important resources found in alluvial sediments, such as placer minerals and sandstone-hosted copper and uranium.

Deposition of thick alluvial sequences in basins formed under a wide range of changing tectonic regimes and contrasted sub-regimes, e.g., the Eureka Sound Formation, has led Miall, if the reviewer interprets him correctly, to feel that the term "molasse" belongs to a tectonically more innocent era. However, for lack of an alternative Miall is reluctant to abandon this still useful term. One way to solve this problem, perhaps the main question raised in this book, is to give the term the flexibility to adapt to our increasing knowledge of the tectonics of alluvial basins by making it synonymous with "thick, mainly alluvial sequence" and prefacing it with an expression tying each case to its causal tectonic sub-environment, e.g., rifting-valley molasse, outer-arc trough molasse or wrench-fault basin molasse. The term "molasse" in its original sense would be preserved under the name "foredeep molasse".

The title of this book suggests a relevance to alluvial basins of all ages, whereas only Devonian and later sequences are treated. By leaving out earlier alluvial sequences the book does not address one important aspect of clastic sedimentology, the effects of the evolution of land plants.

In summary, these generally well written papers should stimulate and inform the specialized reader.