Mineral deposit modelling (Papers presented during 8th IAGOD meeting, 1990)

*Edited by R V Kirkham,
W D Sinclair, R I Thorpe, and
J M Duke*

Geological Association of Canada
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There is a wealth of information in this recently produced book which contains 40 papers on 798 pages printed on high-quality paper; it is the best available single volume of information for a wide variety of metallic mineral deposit types. The papers were presented at an IUGS/UNESCO conference on mineral deposit modelling held in conjunction with the 8th IAGOD symposium in Ottawa in August 1990. The volume is dominated by North American authors with 75% of the authorship, including 35% from the USGS and 20% from the GSC which also provides the four editors who have done an excellent job in bringing this important volume to publication in such a uniform format. Four papers cover general principles averaging 8 pages each; five are on applications of ore deposit models in resource assessment and exploration averaging 11 pages; 25 on individual ore deposit models averaging 24 pages and 7 on computer processing of data averaging 12 pages. The lengths of the ore deposit model chapters range from 52 pages on sedex mineralisation to eight on Outokumpu Cu–Zn deposits. Many of the papers were revised after presentation and include references up to 1991. Generally, the diagrams, are of high quality, typical of the style associated with GAC publications. These usually include diagrams illustrating the genesis of the deposit type in useful cartoon style.

The chapters range widely through the spectrum of mineral deposit types, although there is no paper giving an overview of the currently accepted types. The papers are wholly concerned with metalliferous mineralisation, apart from one paper on evaporites (borates, iodides, chlorides and nitrates) in the Andes of Argentina, Bolivia and Chile. Continuing controversy in the field of mineral deposit modelling is illustrated by the appearance of the same deposit in several different mineral deposit types. For example, the Kiruna deposit is listed as an Algoma-type iron deposit and also tentatively linked to Middle Proterozoic Olympic Dam-type Fe (Cu) (Au) deposits. The Broken Hill and Sullivan deposits appear in the sedex section and also in the Broken Hill-type, erected by Ian Plimer and linked to the Swedish Bergslagen and other Proterozoic Pb–Zn deposits on the basis of their intra-

continental rift setting, presence of granite sills, presence of fluorine and other associations. Many of the papers are accompanied by an invaluable listing of the major deposits of the type described, together with a grade/tonnage diagram.

It is almost a relief to open an economic geology text and not find it dominated by gold deposits. There are gold-related chapters on iron-formation hosted gold deposits, palaeoplacer gold and uranium deposits, two on epithermal deposits, gold-rich porphyry copper deposits, precious metals related to alkalic igneous rocks and mesothermal lode gold. There are some useful contributions to lesser known deposit types and areas, including Chinese copper-nickel and vein tungsten deposits.

Inevitably the volume cannot be comprehensive. There is no chapter on sediment-hosted stratiform copper mineralisation—a striking omission, though Boyle and others (1989) remains the standard comprehensive source. There is a chapter on the Nifty copper deposit in Western Australia which was found during exploration for the SHSC-type, but in fact turned out to be intermediate between the classic SHSC- and the Sedex Pb/Zn-type but with copper instead of zinc. There are also no chapters on surficial or residual deposits and nickel is only mentioned in the Chinese paper above. Diamonds and gemstones generally are not mentioned. The iron ore chapter is rather short for such an important element and is restricted to North American examples, especially the Algoma- and Lake Superior (BIF)-types. The historically important Jurassic ores of Europe are not mentioned and the minute Irish Tynagh iron formation is listed as an Algoma-type although these are generally associated with volcanic activity and spreading ridges rather than a Sedex Zn–Pb deposit.

The application of computer-assisted modelling and 'expert' systems is briefly covered, though the Bonham-Carter paper on GIS assisted modelling of VMS potential in the Flin Flon area is a good example of the methods possibilities and is accompanied by a number of excellent colour images. The paper on computer modelling of coal deposits also includes colour sections, plans and digital terrain models.

The index is generally good but has an idiosyncratic listing of many deposits under the sub-heading 'deposits' or 'mines' rather than the name of the deposit. Thus one can find Navan under 'deposits', but not under 'Navan' but Neves-Corvo appears under both headings.

The cost of Can \$180 is extremely good value and the volume can be strongly recommended for inclusion on every economic geologist's personal, as well as corporate, bookshelf.

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History of geology—an international happening— the geologists at Prague: August 1968

Cecil Schneer, *Eath Sciences History*,
v. 14 no. 2, pp.172–201, 1995

For English-speaking geologists, the history of the discipline usually means a nodding acquaintance with the names Hutton and Lyell and the odd word 'uniformitarianism'. The Germans have their hero Werner, the French Cuvier, the Italians Arduino and the Russians Lomonosov. Most geologists would be surprised to know that the history of geology as an academic discipline is alive and well, combining the skills of geologists and historians and with a research rigour matching that of other branches of geology.

The International Commission for the History of Geology (INHIGEO) is one of the longest established of the IUGS Commissions, dating from 1967. It is particularly fitting therefore that Cecil J Schneer, petrologist and long-term US representative on the council of INHIGEO from its inception, accepted the invitation to write a history of IUGS. It is interesting also that Schneer focuses not on the beginning (1961) but at a pivotal point in the history of IUGS: the aborted 1968 IGC Congress in Prague. As a participant in the events of August 1968, Schneer is well placed to call on his own experiences and records, supplemented by interviews and extensive documentation. He deals well with the international tensions within the geological community that existed prior to the meeting and those that arose during the IUGS Council and Executive meetings as Russian tanks entered Prague and put an end to the Congress. It is a fascinating and startling story, told clearly and succinctly, with no attempt to gloss over personal and national differences, but in the end is a most positive statement of how the geological community rose above such differences to ensure the continuation of international cooperation.

Since 1968, there have been many changes in the world political scene and there have been local and international pressures that affected IUGS, such as French-Canadian pressures at the Montreal IGC, the replacement of Taiwan by China in 1976, a partial boycott of the Moscow IGC and so on. The extent of the change in the 1990s was emphasised by a colleague from former East Germany 'Now I can go to any conference I like—but of course I can't afford it'! Schneer has clearly a rich vein to mine to bring his story up to the present. This important sequel is something to look forward to. Hopefully it will not be too long coming.

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Sequence stratigraphy of foreland basin deposits

Edited by J C Van Wagoner

AAPG Memoir 64, 1996, 487 pp., hardback, US\$134 (\$89 for AAPG members), ISBN 0 89181 343 8.

This is the fourth AAPG memoir dealing specifically with sequence stratigraphy and concentrates on examples from the foreland basin of the Cretaceous interior seaway of North America, from New Mexico to Alberta.

Sequence stratigraphy is a rapidly evolving field, the terminology of which has become ever more complex and in some cases confusing and contradictory. The introductory overview by Van Wagoner is an excellent summary of the development of the subject and its associated jargon.

For the reader interested in the principles of sequence stratigraphy, rather than the detail of particular basins, there are several papers of particular interest. The paper by Krystinik and DeJarnett provides food for thought regarding the validity of the common assumption of basin-wide synchronicity of sequence stratigraphic surfaces observed in one part of a basin in tectonically active basins. Detailed biostratigraphic correlation reveals that there is wide variation in the stacking patterns of time-equivalent deposits with examples of sequence boundaries being equivalent to maximum flooding surfaces.

The paper by Schwans considers the complex interplay between eustasy, tectonics and sedimentary flux in foreland basins. It contrasts the resultant stratigraphy in the proximal zone, closest to the thrust where subsidence rates and sediment input are highest, and the distal zone further away where subsidence is mainly flexural in nature and sediment input lower. Unconformities in the proximal zone are found to be tectonically enhanced '3rd order' unconformities whereas those in the distal zone are predominantly '4th order' and eustatically controlled. The increasing development of unconformities controlled by eustasy with time due to decreasing subsidence rates is also commented on.

Pemberton and MachEachern's paper provides a useful reminder of the value of trace fossils in characterising vertical facies changes and in correlating unconformity surfaces which may have quite different lithological expressions over short distances.

Other papers are concerned more with the details of individual parts of the foreland basin and provide extremely useful references to those readers with particular interest in these areas. All are very detailed with plenty of excellent annotated photographs detailing field relationships, correlation diagrams and stratigraphic summary charts. Most also consider correlation from outcrop to successions encountered in the subsur-

face. They provide the reader with valuable reference material for comparative purposes in their own study areas. Most, in addition, attempt to present lessons learnt from these studies which might have a wider application. Space does not permit a detailed assessment of all these contributions. The following is a summary of some of the more notable.

Shanley and McCabe's paper details the criteria for the recognition of base level changes from changes in stratigraphic architecture in predominantly alluvial to shoreface successions in southern Utah.

Van Wagoner, in his 87 page paper, examines the Desert and Castlegate members of the Blackhawk Formation of the Book Cliffs in Utah in great detail, including many correlation diagrams with explanatory diagrams and annotated photographs of field exposures. He also traces sequence and parasequence boundaries from marine to non-marine strata and interprets changes in sandstone body architecture in non-marine strata in terms of changes in base level. Other notable points are the fact that the number of sequences are an order of magnitude larger than that predicted by Haq's sea level curves and that sharp-based lower shoreface sand bodies cannot be taken to indicate the base of forced regressive successions, in contrast to the view expressed by Nummedal and Molenaar in this volume, but may be controlled by storms alone acting during progradation of a HST.

Nummedal and Moelnaars paper on the Gallup Sandstone of New Mexico documents the nature and extent of the marine and subaerial erosion surfaces thought to be produced during falling sea levels and which bound the forced regressive deposits or 'falling stage systems tract'. Details of the ravinement surface produced during the subsequent sea level rise are also provided.

Obyrne and Flint's paper on the sequence, parasequence and intraparsequence architecture of the Grassy member of the Book Cliffs in Utah is a useful study of the hierarchy of scales of stratal surfaces and the stacking patterns of bedsets, parasequences and sequences. It also emphasises the limitations of lithostratigraphy in providing a useful framework for understanding the processes of basin infilling.

In summary, this book is an invaluable addition to the sequence stratigrapher or indeed any geologist dealing with siliciclastic successions, and in particular those dealing with successions on 'ramp-type' basin margins. Although it is unlikely to be read from cover to cover in one go, it provides a tremendously detailed reference which can be 'dipped into' time and time again. The papers are on the whole excellently illustrated and the book provides an up-to-date summary of the current understanding of sequence stratigraphy in foreland basins.

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The Grampian Highlands (4th edition)

The following letter has been received following the publication of Professor Shackleton's review in the last issue of *Episodes*

Dear Editor,

Professor Shackleton's objective critical review of *The Grampian Highlands* (*Episodes* v. 19 no. 3) is welcomed and most of his detailed criticisms are accepted, although he would find, on closer inspection, that some of his points have been dealt with (see for example, the comments on correlation of phases of deformation on pp.77-79). However, it is felt that he has misunderstood the purpose of the volume and indeed of the *British Regional Geology* series in general.

This series aims to present a comprehensive, up-to-date summary of the geology of the United Kingdom, aimed at A-level- undergraduate level, but hopefully also of use to researchers and professionals. The volumes are valued as source books for information that draws together the results of published work and enables the reader to locate more-detailed information that he or she may require. In the case of *The Grampian Highlands* and its companion *The Northern Highlands*, the large geographical and subject areas covered and the general lack of district memoirs, accompanying 1:50 000 geological maps, has been recognised by increasing the amount of detail included and by much more comprehensive reference lists than in other volumes of the series. Inevitably, this has led to restrictions on the amount of discussion and also, regrettably, on other features such as the size of the index.

The volumes are intended to stand the test of time; in this case it has been 30 years since the last edition. They concentrate on the results of published work. As a general principle, detailed discussions of general or global theories are avoided on the grounds that they may become dated. In the case of Scotland in particular, this is not seen as a problem. We are fortunate in having the *Geology of Scotland*, already in three editions. A fourth edition now in preparation (by the Geological Society Publishing House), will concentrate more than ever on unifying theories of basin, magma, structure and tectonic development. Like its predecessors, this will be the ideal complement to the *British Regional Geology* series, free from the need to present a fully comprehensive, essentially descriptive account of the geology; it may even have some BGS authors.

With regard to the specific points mentioned, we regret the errors in Table 1 which are due to unnoticed late-stage changes to the typesetting. Several columns are affected, including the timescale, and these will be corrected when the book is reprinted in the not-too-distant future.

Although the Central Highland Migmatite Complex is generally separated from the Grampian Group by the Grampian Slide, in places there is a lateral transition. The slide zone contains pegmatites, dated at 750 Ma at the time of publication of the book and more recently amended to c. 800 Ma; dates of c. 850 Ma have now also been obtained from rocks within the migmatite complex. The Grampian Group passes stratigraphically and structurally upwards into the Appin Group. Thus, although some of the older rocks are probably coeval with parts of the Moine, it was considered most appropriate to follow Harris et al. (1978) and assign the Grampian Group to the Dalradian (a decision repeated almost simultaneously, but independently, on behalf of the

Geological Society by Gibbons and Harris, 1994). Notwithstanding this decision, an attempt was made to guide the reader through the various schools of thought as objectively as possible (pp.20–21, 32–33), and to be deliberately non-committal about the assignation of the migmatite complex (pp.29, 99–101).

It is hoped that *The Grampian Highlands* will continue to be the useful source book that Professor Shackleton recognised it to be.

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