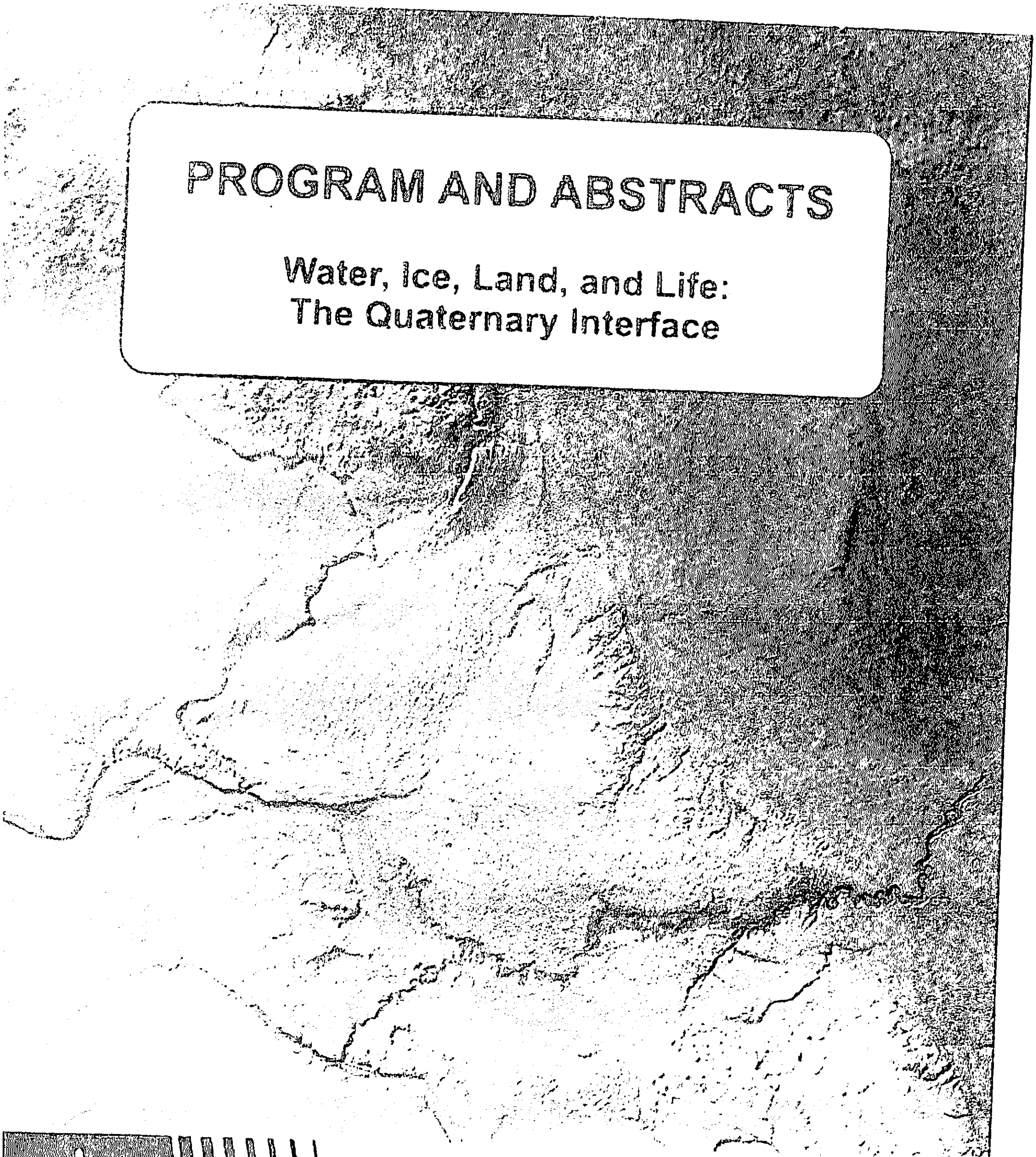

PROGRAM AND ABSTRACTS

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CARBONATE HARDGROUNDS IN MAARS OF WESTERN VICTORIA, AUSTRALIA: A GLIMPSE AT MODERN LACUSTRINE DOLOMITE FORMATION

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The Western Victorian Plains physiographic province of southern Australia contains the greatest concentration and diversity of salt lakes in the entire Southern Hemisphere. The paleolimnology of many of these basins has received considerable attention because of their excellent high-resolution stratigraphic records, which provide important clues about the past climate and hydrology of Australia. In contrast, the modern sediments in these lakes are less well-studied despite the occurrence of a great spectrum of unusual carbonate and evaporite-precipitating environments.

Lakes Gnotuk, Bullenmerri and Keilambete occupy small, deep craters in the central part of the Volcanic Plains. Modern water levels and brine salinities fluctuate dramatically and even greater fluctuations have been deduced from their offshore stratigraphies.

The modern shoreline and nearshore sediments in these basins are dominated by well-indurated carbonate hardgrounds. These dolostones and limestones show a great variety of textures, fabrics and compositions. Morphologically, they range from flat, featureless to laminated wackestone pavements, with variable polygonal fragmentation, to algal boundstones and microbialites having relief of more than a meter.

The complex climate-driven hydrological changes, coupled with multiple exposure and associated diagenetic effects have created an exceedingly complex petrologic record in these hardgrounds. Although their genesis and diagenesis are complex, there is abundant evidence to support mineral formation by both primary inorganic precipitation and by biologically-induced cementation. Similarly, both transformation (chemical and structural alteration of pre-existing minerals) and neoformation (precipitation directly from pore or lake fluids) processes have been important in creating and diagenetically altering these shoreline carbonates.

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DOLOMITE, MICROBIOTA, AND SALT LAKES OF WESTERN CANADA

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Dolomite formation and dolomitization in the sedimentary realm are subjects of long-standing interest and study. Probably no other mineral or sedimentary rock has attracted as much speculation regarding its origin and genesis as dolomite. For Quaternarists, modern and Holocene dolomite formation seems to elude a clear understanding, and there is still considerable difference of opinion regarding the occurrence and genesis of "modern" and Quaternary dolomite. As we celebrate the 75th anniversary of the first scientific report on Quaternary lacustrine dolomite, it is fitting to summarize our current understanding of the origin and genesis of this intriguing and economically important mineral in the lakes of western Canada. We also use this opportunity to outline our new phase of investigation and examination directed at deciphering the role of microbiota in initiating and controlling Ca-Mg carbonate mineral formation and diagenesis in these lakes.

Western Canada is home to over half of the reported occurrences of modern non-detrital lacustrine dolomite in North America. Nearly all of these are from the saline and hypersaline lakes of the Prairie region of Alberta, Saskatchewan, and Manitoba. Although the precise mechanism(s) by which the dolomite is forming in these lakes remains elusive, there is now overwhelming petrographic and geochemical evidence that most of the fine-grained Ca-Mg carbonate material comprising the lacustrine surficial and Holocene sediment is a true <u>primary</u> precipitate. In Freefight Lake located in southwestern Saskatchewan, and several other deep, saline and meromictic basins, there is evidence that at least some dolomite formation and diagenesis is biologically mediated. It has been shown by various researchers that the production of carbonate particles by some microbes, for example, sulphate-reducing bacteria and cyanobacteria is due to their use of different metabolic pathways of the nitrogen and sulphur cycles. At this point it is not fully understood how these mechanisms induce carbonate precipitation and diagenesis. Our goal in this ongoing research project is to provide insight into the long-standing 'dolomite problem' by examining the role of microbial processes in the formation of carbonates in lakes across a range of environmental conditions. We wish to ascertain if the precipitation is due in part to changes in the water chemistry caused by these metabolic processes (i.e., an increase in alkalinity) and/or by a change in the microbial cells that encourages nucleation and growth of the mineral.

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SALTS AND LAMINATED EVAPORITIC CARBONATES: NEW INSIGHT INTO A CENTURY-OLD DILEMMA

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Laminated evaporitic carbonates and thick accumulations of salts have posed interesting sedimentological and paleoenvironmental enigmas for over a century. Unlike most of sedimentary geoscience, the present is not a particularly useful key to the past when dealing with this realm of deposition. Indeed, much of our understanding of the sedimentological and geochemical characteristics of the "deep water-deep basin", "shallow water-shallow basin", and "shallow water-deep basin" evaporite facies models stems from examination of ancient sedimentary rock sequences rather than the application and study of modern and Holocene examples. The result of this situation is a lack of understanding of paleoenvironmental conditions that is in striking contrast to the importance evaporites and laminated carbonates assume in the interpretation of past climates and basin hydrology. The saline and hypersaline lakes of the Prairie region of western Canada offer considerable insight into this interpretive dilemma.

The modern and Holocene salt lakes of western Canada comprise a spectrum of depositional basins with varying geochemistry and morphology. Deep water-deep basin evaporates and carbonates are represented by modern Freefight, Deadmoose, and Little Manitou lakes. Chappice and Muskiki lakes are end-member examples of shallow water-shallow basin settings. The thick Holocene salt sequences in Ingebright and Ceylon lakes represent deposition from shallow water-deep basin environments. While our sedimentological and geochemical understanding of these basins has advanced considerably, these depositional models are based on very limited knowledge of biological and bio-mediated mineral formation processes. A better knowledge of the specific role that biota play or the conditions in which these organisms are present within each of these models will help with our interpretation of the environmental conditions that the salts and laminated evaporative carbonate minerals represent.

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LITHOSTRATIGRAPHY AND MINERALOGY OF RIVERINE LAKES FROM THE RED RIVER VALLEY OF SOUTHERN MANITOBA AND NORTH DAKOTA

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As a result of a low rate of meander formation for the Red River, a surprisingly small number of channel scar and oxbow lakes occur on the floodplain in the 150 kilometers between the terminus of the river at Lake Winnipeg and the Canada/United States border. The only two such perennial lakes are Lake Louise, located 2 km west of the Red River near Emerson, MB, and Horseshoe Lake, located about a kilometer east of the river near Morris, MB. A third lake included in this study, Salt Lake, is neither an oxbow nor a channel scar basin, and is located 10 km west of the Red River near Grafton, ND. Abundant observational evidence indicates that each of these three lakes receive water from the Red River during major flood events. Lake Louise and Horseshoe Lake were both inundated during the 1997 flood; Salt Lake receives water from the Red River due to back-flooding of the Park River. Thus, the stratigraphy of each of these basins should provide a long-term (several millennia) record of major floods on the Red River.

All three basins are small and shallow but perennial. Lake Louise is an elongate (~2 km x 0.2 km) channel scar basin with a maximum depth of less than 3 meters. Horseshoe Lake is a slightly smaller oxbow lake with a depth of approximately 2 meters. Salt Lake has a more equant shape than the other two basins, however it has a maximum depth of less than one meter. Lake Louise and Horseshoe Lake are both hydrologically closed basins, whereas Salt Lake has an outlet to Park River, which connects to the Red River.

High-resolution bulk mineralogy and detailed evaporite, carbonate, and clay mineralogy of cores taken from these three basins, coupled with particle size, chronological and geochemical analyses provide valuable insight into overall late Holocene lacustrine evolution in this region. However, because of post-depositional sediment mixing in these shallow basins and the fact that there is little difference in composition, grain size, or provenance between flood-derived inorganic sediments versus 'normal' lacustrine deposits, the physical, mineralogical, and inorganic geochemical lithostratigraphy of these basins offer little promise for deciphering long-term paleoflood frequency or intensity.

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BIG & SALTY: GEOLIMNOLOGY AND PALEOLIMNOLOGY OF SALINE LACUSTRINE GIANTS OF THE GREAT PLAINS

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The northern Great Plains region of western North America contains millions of saline and hypersaline lakes. Most of these lakes occupy small, shallow basins; many are ephemeral; most have only relatively thin Holocene stratigraphic sequences. However, the region also contains lacustrine "giants": salt lakes of atypical size, exceptional depth, and/or unusual sediment thickness. Ingebright and Metisko lakes, located in western Saskatchewan and eastern Alberta, contain extraordinary thicknesses of Holocene salts and, together, contain marketable reserves of sodium sulfate nearly equal to all of the rest of North America. Lake Manitoba, at the eastern edge of the Prairies, and the Quill Lake basins, in south-central Saskatchewan, are among the largest saline lakes in North America. Freefight Lake, in southwestern Saskatchewan, is not only the deepest salt lake in the Great Plains of North America but also the most saline perennial lake in Canada.

Knowledge and understanding of the geolimnological processes operating in these basins provide sedimentologists with an unparalleled opportunity to better decipher ancient lacustrine basins. Furthermore, these saline giants offer a tremendous wealth of paleohydrological and paleoenvironmental information that is commonly obscured or more difficult to interpret from smaller lakes of the Prairie region.

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18TH CENTURY DROUGHT IN THE PEACE-ATHABASCA DELTA, ALBERTA, RECORDED BY LAKE SEDIMENTS AND TREE RINGS

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The Peace-Athabasca Delta (PAD), situated at the confluence of the Peace and Athabasca rivers at the western end of Lake Athabasca in northern Alberta, is one of the world's largest freshwater deltas and is recognized internationally for its ecological, historical and cultural significance. Floods caused by ice-jams on the Peace River are key for replenishing water to high-elevation perched basins in the PAD that provide important wildlife habitat. Concerns over the potential linkage between regulation of the Peace River in 1968 for hydroelectric production and low Peace River discharge between 1968 and 1971 during the filling of the Williston Lake reservoir, absence of a major ice-jam flood event between 1974 and 1996, and low water levels in perched basins during the 1980s and early 1990s have sparked numerous environmental studies largely aimed at restoring water levels in the PAD. Lack of sufficient long-term hydrological records, however, has limited the ability to objectively assess the importance of anthropogenic factors versus natural climatic forcing in regulating hydro-ecological conditions of the PAD.

Here we present results from stable isotope analyses on a tree-ring series from near the headwaters of the Athabasca River and multi-proxy paleolimnological studies of PAD basins that document extremely dry conditions during the 1700s, well beyond that observed in recent decades. Reconstructed relative humidity and mean annual temperature, based on coupled carbon and oxygen isotope analyses of the Athabasca tree-ring record, indicate cold and very dry conditions during the 1700s corresponding to the latter part of the Little Ice Age. Downstream, hydrological expression of this climatic episode is evident from lake sediment derived reconstructions of Peace River flood frequency and perched basin water balance history in the northern Peace sector of the PAD. High-resolution analyses of magnetic susceptibility from an oxbow lake adjacent to a major flood conduit of the Peace River, which provides a record of Peace River flooding, suggests exceptionally low flood frequency during the dry 1700s. Correspondingly, multi-proxy evidence from sediments of "Spruce Island Lake", an elevated perched basin, indicates the driest period of the past 300 years occurred during the 1700s.

Evidence for prominent 18th century drought in the PAD is consistent with tree-ring reconstructions of low streamflow for the North Saskatchewan River and regional glacial advances in the Rocky Mountains illustrating the strong and over-riding historical dependence of western Prairie river discharge on upstream glacier mass balance.

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