Outcrop Stratigraphy and Sedimentology of the Lower Cretaceous Isachsen Formation of the Sverdrup Basin, Ellef Ringnes Island, Arctic Canada

Dylan Tullius
Department of Geoscience University of Calgary, Calgary, AB, Canada
dntulliu@ucalgary.ca
Owen Anfinson
Department of Geoscience University of Calgary, Calgary, AB, Canada
oaanfins@ucalgary.ca
Andrew Leier
Department of Geoscience University of Calgary, Calgary, AB, Canada
aleier@ucalgary.ca
Per Pedersen
Department of Geoscience University of Calgary, Calgary, AB, Canada
pkpeders@ucalgary.ca
Bernard Guest
Department of Geoscience University of Calgary, Calgary, AB, Canada
bguest@ucalgary.ca

Abstract:

The Sverdrup Basin is an elongate triangular shaped basin in the Queen Elizabeth Islands stretching over 1500 km from Banks Island in the west to northern Ellesmere Island in the east. More than 8 km of Mesozoic strata are preserved in the basin containing the thickest and most complete succession in the Arctic region. The Lower Cretaceous Isachsen Formation is a widespread clastic sequence ranging from 10-1400 meters thick from its distal edges to the basin's center west of Axel Heiberg. The formation has been a target for both oil and gas exploration and also has known coal reserves. Little research been done on this succession since the late 70s due to the remoteness of the area. Wells on Ellef Ringnes Island encountered over 1300 m of Isachsen although the thicknesses of the formation vary substantially across the island in part due to halokineses of Carboniferous salt deposits. In the summer of 2010, four surface stratigraphic sections of the Isachsen were measured at three locations around uplifted salt domes on Ellef Ringnes Island. Although the base of the formation is not exposed at any of these locations the proximity to well sites on the island makes them ideal candidates for surface to subsurface stratigraphic correlations.

The Isachsen Formation throughout the Sverdrup Basin has been interpreted as delta front and delta plain in origin. Blocky, medium to coarse-grained trough cross-stratified sandstone units occur regularly separated by beds of silt and shale. Sandstone beds are generally 2-10m thick but can be as thick as 50m. Coarse-grained quartzarenite pebble conglomerates are found frequently near the base of these sections, some with cobbles up to 30 cm in diameter. Sandstone beds near the top of the formation are generally finer grained but many are still composed almost purely of quartz grains. Although many of these deposits were poorly

to completely unconsolidated, bitumen staining almost always accompanied the more lithified beds. These beds are separated by frequent fine grained sandstone, siltstone and mudstones with bedded organic rich non-marine shale as well as coal beds and stringers up to ½ a meter thick. The Isachsen Formation on Ellef Ringnes Island is conformable with the overlying marine shale of the Christopher Formation. This contact is seen as thin beds of symmetric rippled sandstone grading quickly into shale immediately above the uppermost quartzarenite beds.

The Isachsen Formation was broken up into formal members by Embry in 1984 after recognition of a thin succession of marine shale near the center of the basin. Although this marine shale often has an easily recognizable signature on well logs, the dearth of fauna and abundance of shale within exposures of the Isachsen Formation makes it a difficult unit to use in surface correlation. Previous attempts to subdivide the Isachsen Formation were made by Balkwill, Roy and Miall from 1977-1983. Although no formal classifications were attempted, recognition of a higher concentration of pelitic sediments near the middle of the formation allowed for informal member classification. This broad lithostratigraphic subdivision is reflected in the sediments on Ellef Ringnes Island with larger and more frequent sandstone units occurring near the base and top of the formation separated by a middle shale dominated succession.

Due to the nature of fluvial-deltaic sequences, fine-scale correlations between outcrop and well-log data even over short distances can be problematic. However, direct correlations can be made between larger lithostratigraphic packages of varying thickness across the study area. Tectonics in this central area of the Sverdrup Basin is overwhelmingly defined by halokinesis. Halokinetic features have been shown to be active throughout much of the Mesozoic and may be responsible for directing some of the major channel sands within the Isachsen Formation. By analyzing surface and subsurface changes in sand/shale ratios across the island within these lithostratigraphic packages we can attempt to identify the change in style of fluvial deposition and reservoir quality which may be occurring in and around active salt diapers. These models could be useful analogues for offshore Isachsen targets to the south which are being drilled in and around salt cored anticlines.