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Detailed outcrop measured sections of the St. Mary River and Willow Creek Formations in the foothills of southern Alberta

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Abstract

Since 2004, renewed interest in uranium exploration, spurred by a supply shortage and large increases in world price, has resulted in land-staking, prospecting, ground and airborne surveys and drilling in southern Alberta. Preliminary results demonstrated that the St. Mary River and Willow Creek formations have characteristics similar to known sandstone-hosted uranium deposits in the US. Four outcrop measured sections (1 of St. Mary River Formation and 3 of Willow Creek Formation) are included here, and the facies present are described. The information contained in this Open File adds further sedimentological particulars to our knowledge of those two stratigraphic units, which may harbour some uranium, shallow gas and groundwater potential.

Introduction

Outcrop field study of several prospective Upper Cretaceous stratigraphic units was undertaken in southern Alberta as part of a program to investigate recent industry activity and evaluate the potential for undiscovered sandstone-hosted uranium deposits in the Western Canada Sedimentary Basin (WCSB). This is part of an effort to enhance sustainable energy development and improve the geological framework and conceptual knowledge for areas where uranium prospectivity is relatively unknown. Although poorly-understood in detail, these strata in Alberta are similar in general geology to those which host major uranium deposits in Wyoming and Colorado. Since 2004, renewed interest in uranium exploration, spurred by a supply shortage and large increases in world price, has resulted in a flurry of land-staking, prospecting, ground and airborne surveys and drilling. Preliminary work with Alberta Geological Survey led to the publication of their report, by Matveeva and Anderson (2007), which provided abundant detail and data. Preliminary results of that work demonstrated that the St. Mary River and Willow Creek formations (as well as several others) of southern Alberta have characteristics similar to known sandstone-hosted uranium deposits in the US. Background information on the St. Mary River Formation was summarized by Hamblin (1998b) and similar data is reported for the Willow Creek Formation by Hamblin (in press). The additional information contained in this Open File adds further sedimentological particulars to our knowledge of those two stratigraphic units, which may harbour some uranium, shallow gas and groundwater potential.

Measured Sections

The four outcrop measured sections included here are located in the Foothills southwest of Calgary (Table 1, Figs. 1, 2, 3, and 4), and are easily-accessible examples of the facies and depositional styles present in these Upper Cretaceous units. The section of part of the St. Mary River Formation (Carroll Canyon; Fig. 1) is located about 4 km east of Highway 22, just south of Longview. This section begins somewhere above the base of the formation, and extends for a stratigraphic thickness of 117 m. Additional detailed measured sections of St. Mary River Formation strata in southern Alberta were published by Hamblin (1998a, 1998c). The three short outcrops of Willow Creek Formation (Highway 22 Roadcuts I and II, Waldron Ranch; Figs. 2, 3, 4) are all visible from Highway 22, the two former as highway roadcuts and the latter as a stream cut immediately east of the Highway. The information in this report is presented as standard measured sections with text and descriptions of units.

St. Mary River Formation

General Description

The St. Mary River Formation is typified by thinly interbedded greyish to greenish mudstone, siltstone and fine to medium grained sandstone, with minor coals and rare fossil-rich limestone beds (Douglas, 1950; Tozer, 1956; see Hamblin, 1998b for further details). Mudstones and sandstones occur in approximately equal proportions. A complete treatment of the coeval Horseshoe Canyon Formation was provided by Hamblin (2004). Thicker sandstone beds tend to be lenticular, have erosional bases and fine-upward. Nadon (1993, 1994) interpreted these sandstones to represent anastomosed channels deposited in a long-lived, low-slope seasonal

wetland. Sideritic caliche/hardpan beds are common in the mudstones. Dinosaur bones and trackways are known, fossil roots and wood fragments are common, and fossil molluscs are freshwater species. Various estimated thicknesses have been published for the St. Mary River, but it is likely about 300 m thick. It is approximately coeval with the Horseshoe Canyon Formation of central Alberta, with which it intertongues near Carmangay (Hamblin, 1998a). At Carroll Canyon, 115 m of lower St. Mary River was described, and five facies identified, as follows.

Thick Sandstones Thicker sandstones are 1-3 m thick, grey to buff weathering, fine to coarse grained, and well sorted. Distinctly erosional bases are commonly lined by lags of granules, wood fragments or broken shells, and the beds fine upward. At least one bed displays molds of dinosaur footprints on the base, a feature known from several outcrops of this formation. Trough cross bedding, horizontal lamination and ripple cross lamination with eastward-directed paleocurrents are typical. These are interpreted to represent deposition in fluvial channels.

Thin Sandstones Thin, discontinuous very fine to fine grained sandstones, up to 50 cm thick occur throughout the section, within units of siltstone. They typically have sharp, flat to erosive bases, horizontal or ripple cross lamination, and may fine-upward. Roots are common at the tops of these beds. These are interpreted to represent floodplain splay deposits.

Greenish-Grey Siltstone Units up to 7 m thick of greenish-grey, massive, uniform siltstone with a rubbly texture and weathering pattern are the most common facies at Carroll Canyon, as at most outcrops of St. Mary River Formation. Sub-vertical fractures and scattered caliche nodules are common. Tiny rootlets and a few mollusc shells are rarely present. The blocky texture is interpreted to represent partial pedogenic alteration in the non-marine setting, and these deposits are interpreted to represent the general background sedimentation of the floodplain.

Sideritic Horizons Ironstone concretion horizons, up to 1 m thick, occur in many of the siltstone units. Rather inconspicuous and discontinuous horizons, a few centimeters thick, of small nodular concretions are common throughout the section. More continuous and much more noticeable, thicker beds up to 1 m thick are also present. These beds consist of resistant, rusty-weathering, heavily-fractured calcareous siltstone with calcite veining and roots. They typically have sharp irregular bases and sharp lumpy or bulbous tops. These beds are interpreted to represent paleosol horizons. Fossil pelecypod shells, which may represent terrestrial clams, in vertical position are present in two beds.

Carbonaceous Mudstone Rare, thin (< 50 cm thick) beds of dark grey carbonaceous, silty mudstone occur in the upper half of the section. One occurrence has horizontal lamination, another has wood fragments and leaves. No coals were observed in this section, although thin seams are known from some other outcrops of this Formation. These beds are interpreted as the deposits of minor, short-lived ponds on the floodplain.

Willow Creek Formation

General Description

The Willow Creek Formation is one of the least-understood stratigraphic units of the WCSB. It is typified by alternating vari-coloured (especially reddish) mudstone and lesser grey sandstone, with very few fossils. Mudstone typically dominates over sandstone. Brilliant colour banding of greens, yellows and reds, and numerous horizons of caliche/hardpan are common (Douglas, 1950; Tozer, 1956; see Hamblin, in press, for further details and references). Douglas (1950) identified five members(A-E), most dominated by greenish and reddish mudstones, but with sandstone-dominated zones in the middle and top. Unlike coeval strata of the Scollard Formation to the north, coal is very rare, but very thin seams do occur in the upper part of the formation. The unit is nowhere fully exposed, but was estimated by Tozer (1956) to be up to 1300 m thick, although this may be significantly over-estimated due to structural complications in the Foothills. Douglas (1950) suggested that the Willow Creek is progressively cut-out northward by the overlying sub-Porcupine Hills unconformity. A unique aspect of the Willow Creek, and coeval units, such as the Scollard Formation, is that the K/T boundary is preserved in the middle of the unit (upper part of Douglas' Member D)(Jerzykiewicz and Sweet, 1988; Sweet, 1990; also see Hamblin, in press, and references therein). It is not possible at this time to determine which parts of the Willow Creek stratigraphy are represented by the enclosed short measured sections.

Thick Sandstones Thicker sandstones are 1-3 m thick, grey to pale grey/white weathering, fine to medium grained, and well sorted. Distinctly erosional bases are commonly lined by lags of shale rip-ups, and the beds typically fine upward. Bed tops are usually flat and sharp. Horizontal lamination and ripple cross lamination are prominent, with lesser trough cross bedding. Paleocurrent directions are variable, but generally fall into the eastern hemisphere. These sandstones are interpreted to represent deposition in fluvial channels.

Thin Sandstones Thin, discontinuous very fine to fine grained sandstones, up to 50 cm thick occur throughout the Willow Creek, typically thinly-interbedded with units of siltstone. In the upper Willow Creek sections, these sandstones are the second most-common facies, after siltstone. They typically have sharp, flat to erosive bases, horizontal or ripple cross lamination, contorted lamination, and may fine-upward. Rare trough cross bedding occurs in a few beds. Roots are common at the tops of these beds, and some display minor horizontal burrows. A small number of paleocurrent measurements suggest depositional flow toward the eastern hemisphere. These sandstones are interpreted to represent floodplain splay deposits.

Vari-coloured Siltstones Units up to 8 m thick of greenish-grey, reddish-grey, and whitish or yellowish massive, uniform siltstone are the most common facies in the Willow Creek Formation. These typically have a blocky, rubbly texture and weathering pattern. Sub-vertical fractures, rootlets and scattered caliche nodules or sideritic horizons are common. Thin beds of fine sandstone, as described above, are commonly present. The blocky texture is interpreted to represent partial pedogenic alteration in the non-marine setting, and these deposits are interpreted to represent the general background sedimentation of the floodplain.

Sideritic Horizons Thin ironstone concretion horizons, up to 20 cm thick, occur in many of the siltstone units. Rather inconspicuous and discontinuous horizons, a few centimeters thick, of small nodular concretions are common throughout the section. More continuous and much more noticeable, thicker beds up to 1 m thick are also present. These beds consist of resistant, rusty-weathering, heavily-fractured calcareous siltstone with calcite veining and roots. They typically have sharp irregular bases and sharp lumpy or bulbous tops. These beds are interpreted to represent paleosol horizons. Fossil pelecypod shells, which may represent terrestrial clams, in vertical position are present in two beds.

Carbonaceous Mudstones Uncommon, thin (< 50 cm thick) beds of dark grey carbonaceous, mudstone occur in each of the measured sections. They are most numerous in the Highway 22 Roadcut I (North) section of the upper Willow Creek. No coals were observed in these sections, and coal is very rare in this Formation. These beds are interpreted as the deposits of minor, short-lived ponds on the floodplain.

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Table 1. Locations of measured sections.

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