Late Cretaceous age dates of bentonite beds in southwestern Manitoba

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Introduction

The Manitoba Geological Survey (MGS) has had a project since 2012 to date layers of Lake Cretaceous altered volcanic ash known as bentonite in southwestern Manitoba. The objective of the project is to provide the absolute ages of bentonite beds to help resolve cross-sectional modelling discrepancies and provincial 'boundary faults' that result from stratigraphic units that are time transgressive from west to east across the Western Canada Sedimentary Basin (Bamburak et al., 2013).

The Late Cretaceous volcanic ash beds are between 120 and 60 million years old. The ash travelled by wind from the Elkhorn Mountains of western Montana; much in the way that volcanic ash erupted from Mount St. Helens in the state of Washington a few years ago, and drifted to Manitoba, forming a dusty film on cars and other buildings. The volcanic ash contains tiny crystals of a datable mineral called zircon that effectively recorded the moment that the volcanic eruption took place. This age is then used to approximate the time when the volcanic ash settled in Manitoba and North Dakota, in a huge seaway that then covered most of what is now western Canada and north central United States.

The bentonite beds, sampled to data, are present in the Upper Cretaceous Belle Fourche Member of the Ashville Formation upward to the Odanah Member of the Pierre Shale (Figure 1).

Methodology

From 2012, Late Cretaceous bentonite samples underwent mineral separation, processing and analysis at the University of Alberta (UofA) Radiogenic Isotope Facility in Edmonton, Alberta (described in Bamburak et al., 2013; Bamburak and Heaman, 2016). Then beginning in 2015, the geochronological studies were conducted at the University of Toronto (UofT) Jack Sutterly Geochronology Laboratory, Toronto, Ontario (Bamburak et al., 2016). The latter facility used generally the same methods as the UofA, beginning with crushing, pulverizing, sorting, magnetic separation and heavy liquid techniques to recover the zircon grains. Then, the zircon separates underwent conventional U-Pb dating by isotope dilution-thermal ionization mass spectrometry (ID-TIMS). The isotopic ratios, at both facilities, were measured with a Micromass VG 354 Solid Source mass spectrometer using a Daly detector in pulse-counting mode.

Results

From 2012 to 2016, the MGS bentonite dating project has yielded reliable ages for five Upper Cretaceous bentonite beds, mostly within southwestern Manitoba, using U-Pb zircon geochronology:

- **67.2 ±0.4 Ma** for the Odanah Member of the Pierre Shale (Figure 4);
- **80.04 ±0.11 Ma** for the Pembina Member of the Pierre Shale (Figure 5);
- **81.5 ±0.5 Ma** for the Boyne Member of the Carlile Formation (Figure 6);
- **92.54 ±0.28 Ma** for the Assiniboine Member of the Favel Formation (Figure 7); and
- **96.0 ±0.2 Ma** for the Belle Fourche Member of the Ashville Formation (Figure 8).

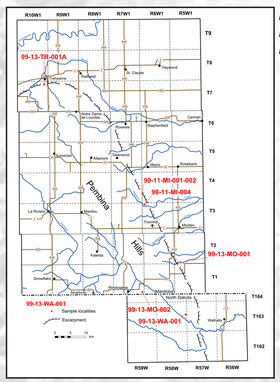

Figure 2: *Bentonite sample localities in the Pembina Hills area of southwestern Manitoba and northeastern North Dakota (from Bamburak et al., 2016).*

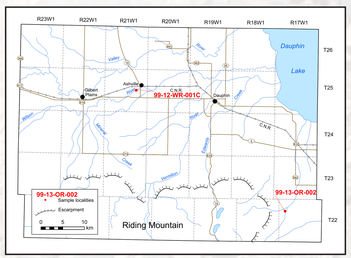

Figure 3: *Location of bentonite samples collected along the north flank of Riding Mountain, west and south of Dauphin, southwestern Manitoba (from Bamburak et al., 2016).*

References

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Bamburak, J.D., Hatcher, J. and Nicolas, M.P.B. 2012: Visual correlation of bentonite seams in the Upper Cretaceous Pembina Member in the Pembina Hills area, Manitoba and North Dakota; Manitoba Mining and Minerals Convention 2012, Winnipeg, Manitoba, November 15-17, 2012, Geoscientific Presentation PRES2012-3 (poster presentation).

Bamburak, J.D., Nicolas, M.P.B. and Hatcher, J. 2013: Radiometric dating of Late Cretaceous bentonite beds in southwestern Manitoba; *in* Report of Activities 2013, Manitoba Mineral Resources, Manitoba Geological Survey, p. 129-136.

Figure 4: *Odanah Member of the Pierre Shale at the Treherne quarry, a few kilometers south of Treherne in 12-25-7-10W1, shown as sample **99-13-TR-001A** in Figure 2 (UTM NAD83, Zone 14U, 520969E, 5495817N; NTS 62G10SE); 2013-05-29.*

Figure 5: *Pembina Member of the Pierre Shale at Pembina gorge roadcut, 7 km south of the US border and west of Walhalla in North Dakota in the northeast portion of Sec. 13, Twp. 163N, Rge. 58W, shown as sample **99-13-WA-001** in Figure 2 (UTM NAD83, Zone 14U, 567221E, 541884N); 2013-07-17.*

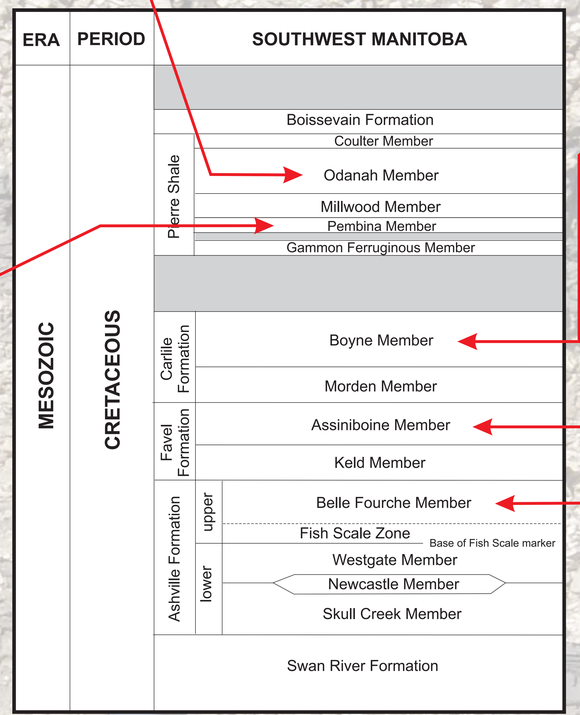

Figure 1: *Cretaceous stratigraphy of southwestern Manitoba.*

Figure 6: *Boyne Member of the Carlile Formation at Spencer's ditch, northwest of Morden, in 15-31-3-6W1, shown as sample **99-11-MI-001-002** in Figure 2 (UTM NAD83, Zone 14U, 553843E, 5457258N, NTS 62G8SW); 2011-08-17.*

Figure 7: *Assiniboine Member of the Favel Formation at Ochre River streamcut, southeast of Dauphin in 9-30-22-17W1, shown as **99-13-OR-002** in Figure 3 (UTM NAD83, Zone 14U, 442837E, 5542134N, NTS 62J13NW); 2007-02-13.*

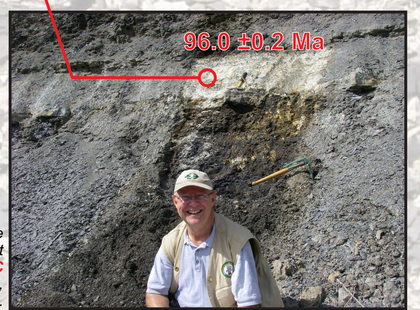

Figure 8: *Belle Fourche Member of the Ashville Formation along the Wilson River, about 1 km southwest of Ashville in 4-14-25-21W1, shown as **99-12-WR-001C** in Figure 3 (UTM NAD83, Zone 14U, 408242E, 5669335N; NTS 62N1NW); 2008-05-22.*