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ABSTRACT

In the Liard Basin of western Canada, Lower and Middle Triassic aged strata comprise a northeasterly sourced, coarsening upward clastic wedge that is overlain by mixed clastic and carbonate units of Late Ladinian to Norian age. This report provides sample information, detrital zircon U-Pb geochronology methodology, results and data tables for a suite of seven samples collected from Lower Triassic to Carnian formations in western Liard Basin. These data show there was no western sourced material and suggest that the clastic material was recycled primarily from the Caledonian and Ellsemerian clastic wedges and the high Arctic. When combined with previously published results for 5 additional samples, they provide a robust reference frame for the Lower Triassic to Carnian succession of the Liard basin.

INTRODUCTION

The Liard Basin, a sub-basin of the Western Canada Sedimentary Basin, is characterized by anomalously thick Upper Paleozoic and mid-Cretaceous strata (Leckie et al., 1991; Wright et al., 1994). The Basin, bounded on the east by the deep-seated Bovie Lake Structure (Figure 1), contains up to 5 km of Phanerozoic strata overlying Proterozoic strata and the Laurentian craton. In Liard Basin the Triassic succession thins markedly from a maximum thickness of approximately 1600 m in the west to a couple of hundred metres in the northeast. Thinning is primarily due to increased erosion beneath the sub-Cretaceous unconformity. Lower and Middle Triassic strata form a northeasterly sourced clastic succession that changes up section from siltstone and shale-dominated (Grayling Formation), to interlayered siltstone, shale and sandstone (Toad Formation) to sandstone dominated (Liard Formation). Younger Middle Triassic and Upper Triassic (late Ladinian to Norian) strata are mixed clastic and carbonate (Ludington and Pardonet formations) and carbonate (Baldonnel Formation) units. These are only preserved beneath the sub-Cretaceous unconformity in western exposures (Figure 2). To a large extent the Grayling and Toad formations are facies equivalents (Gibson et al., 1991). The Liard Formation changes facies westward into the Ludington and Toad formations (Taylor and Stott, 1973; Gordey et al., 1992). McMechan et al. (2012) provide a more detailed description of Triassic Formations exposed in the British Columbia part of the Liard Basin.

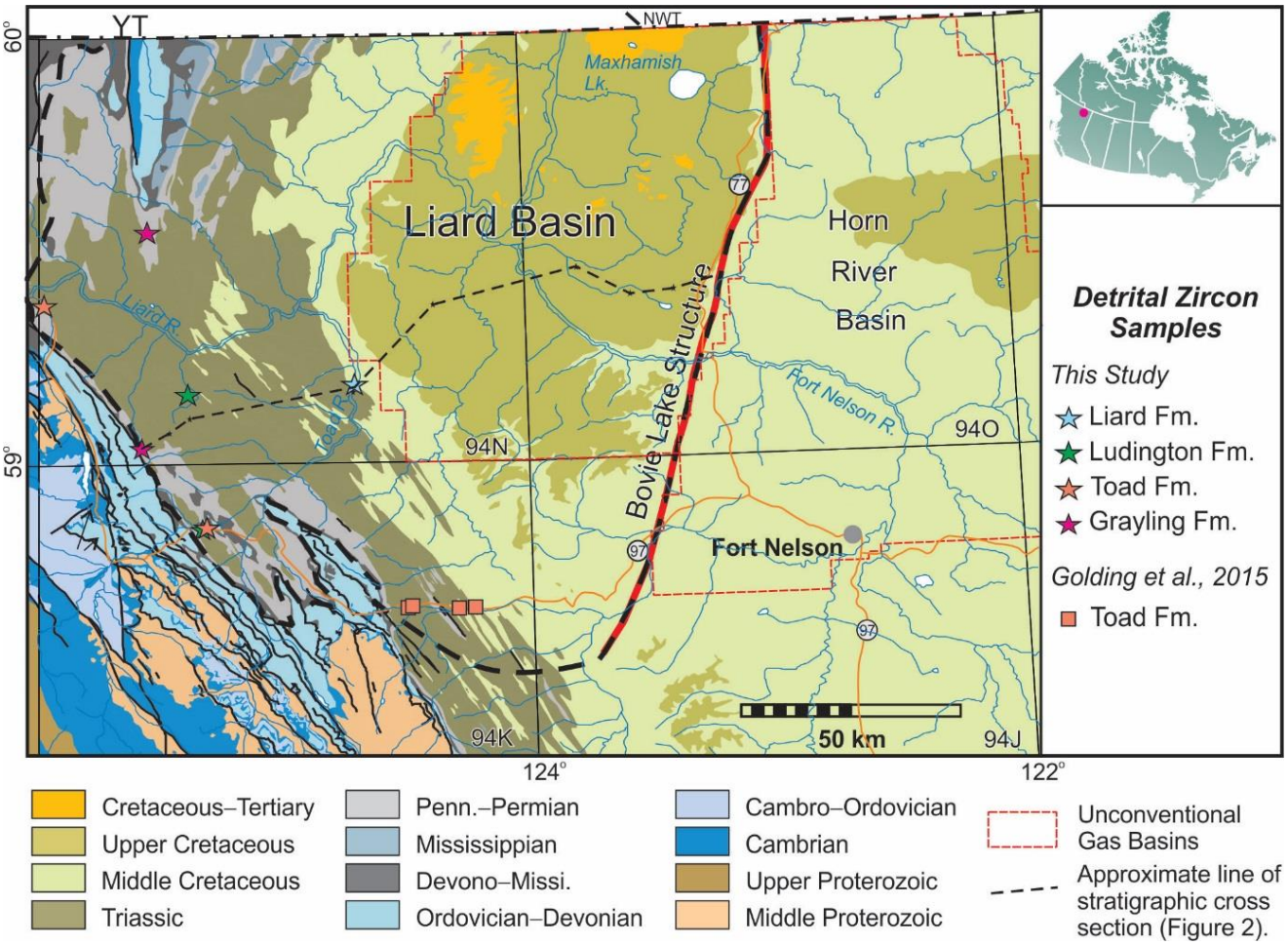

Figure 1. Location of Triassic aged detrital zircon samples analysed.

Seven samples were collected from Triassic strata as part of a larger study examining the detrital zircon provenance of the Liard Basin (McMechan et al., 2015, 2017). These samples are from a broad

stratigraphic interval and included some from the westernmost exposures of the Liard Basin (Figure 1, 2). They were collected to determine: 1) if there was a significant change in detrital zircon U-Pb age signature with stratigraphic level; and 2) if there was a component of west-derived Triassic or upper Paleozoic (< 350 Ma) detrital zircon grains, as had been reported by Beranek and Mortenson (2011) for uppermost Middle Triassic (late Ladinian) ancestral North American margin strata in southeast Yukon 300 km to the northwest. Unlike the Ladinian (uppermost Middle Triassic) Laurentian continental margin strata sampled by Beranek and Mortenson (2011) our samples contained only one younger (< 360 Ma) western sourced grain. Our results show little variation with stratigraphic level. They also indicate recycling of material derived from the Caledonian and Ellsemerian clastic wedges and high Arctic (Figure 3). When combined with published results from 4 samples of the Toad Formation (Golding et al., 2016) and from one sample from the Liard Formation (Gehrels and Pecha, 2014) they provide a robust reference frame for the Lower Triassic to Carnian succession of the Liard basin.

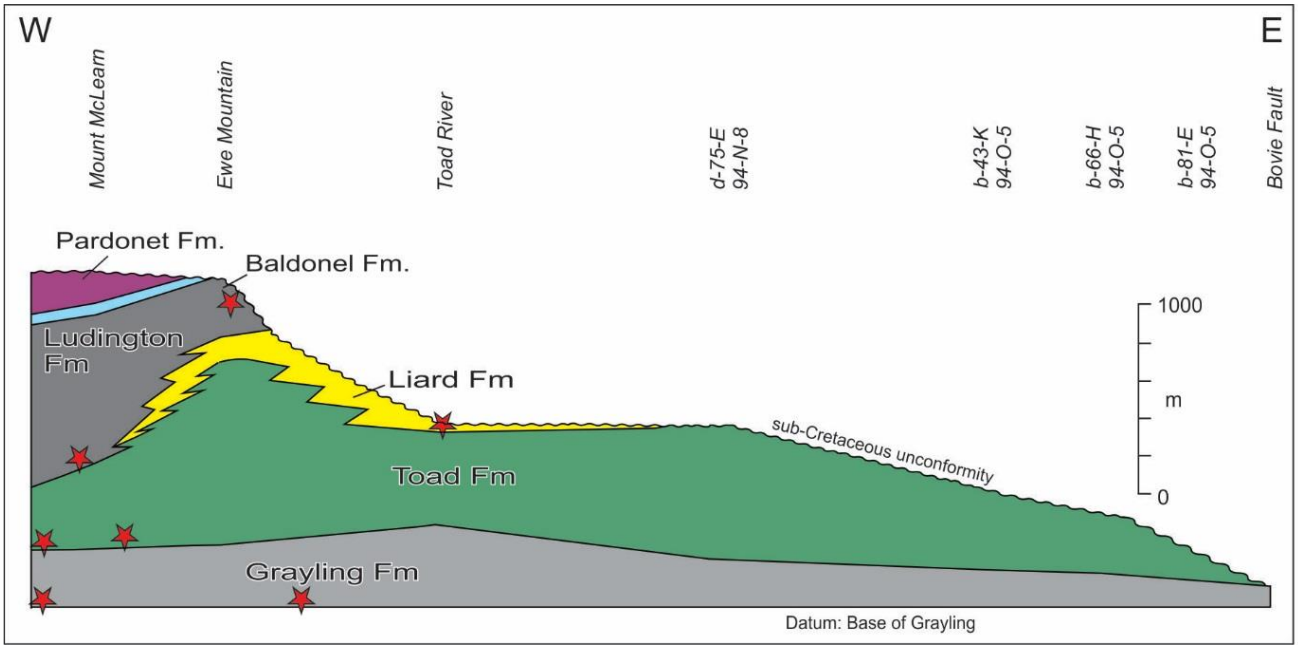

Figure 2. Schematic stratigraphic cross section of Triassic strata across the southern Liard Basin. Red stars show approximate stratigraphic position of detrital zircon samples. See Figure 1 for location.

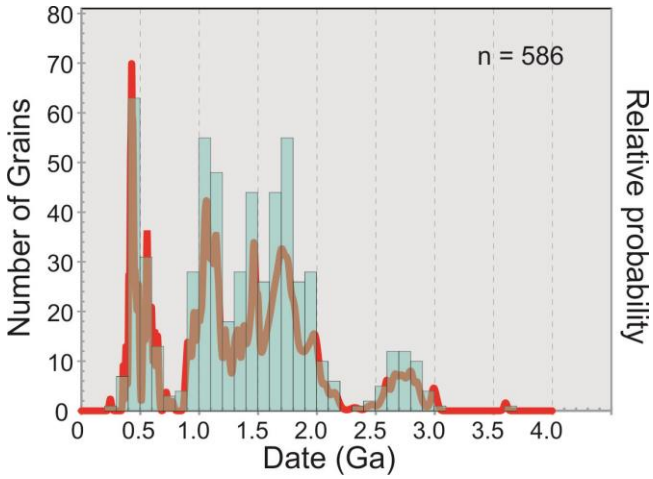

Figure 3. Probability density plot for the combined data set for all samples of Triassic strata in this study.

TRIASSIC SAMPLE INFORMATION

The age estimate provided for each sample is based on Figure 8.55 by E.T. Tozer in Gordey et al. (1992).

Ludington Formation

Detrital zircon U-Pb ages were obtained for two samples of the Ludington Formation from exposures in the western part of the basin (Figure 1, 2). Sample 14MBB001B01 (Figure 4) came from the base of the formation near the southwestern end of the basin and sample 14MBB026B01 (Figure 5) came from 50 m below the Cretaceous unconformity in the central part of the basin.

Field No. 14MBB001B01; GSC Curation No. C-591547; CAPPT lab number: UK021

Lithology: medium brown grey weathering, dark grey, laminated, calcareous, very coarse grained siltstone.

Location: 0365335E, 6525600N NAD83, Zone 10

Estimated age: Carnian

Figure 4. Ludington Formation outcrop sampled for sample 14MBB001B01.

Field No. 14MBB026B01; GSC Curation No. C-591540; CPATT lab number: UK019

Lithology: light grey to brown grey weathering, medium grey, calcareous, very fine grained, quartzose sandstone.

Location: 0363526E, 6560859N NAD83, Zone 10.

Estimated age: Carnian

Figure 5. Ludington Formation outcrop sampled for sample 14MBB026B01.

Liard Formation

Detrital zircon U-Pb ages were obtained for one sample of the Liard Formation from the basal part of the formation along Toad River (Figure 1, 2, 6).

Field No. 13EPF008B01; GSC Curation No. C-571528; CPATT lab number: UK012

Lithology: buff weathering, dark grey, silty, calcareous fine to very fine grained sandstone in medium to thin beds. Character of the Liard Formation along Toad River shown in Figure 6.

Location: 0402654E, 6561908N NAD83, Zone 10

Estimated age: Ladinian

Figure 6. Liard Formation exposed across Toad River from the outcrop sampled for sample 13EPF008B01.

Toad Formation

Detrital zircon U-Pb ages were obtained for two samples of the Toad Formation from exposures in the western part of the basin (Figure 1, 2). Both samples came from near the base of the formation along the Alaska Highway. Sample 14MBB005C01 (Figure 7) came from the first Triassic exposures west of Toad River Lodge and sample 14MBB003A01 (Figure 8) came from the westernmost exposure of the Liard formation south of Liard River Hot Springs.

Field No. 14MBB005C01; GSC Curation No. C-591550; CPATT lab number: UK005

Lithology: brown weathering, grey brown, very fine grained silty sandstone with some calcite veins.

Location: 04366196E, 6525918N NAD83, Zone 10

Estimated age: Nammalian

Figure 7. Sandstone at base of the Toad Formation on the Alaska Highway west of Toad River Lodge sampled for sample 14MBB005C01.

Field No. 14MBB003A01; GSC Curation No. C-591554; CPATT lab number: UK006

Lithology: tan brown weathering, dark grey, calcareous silty, very fine grained sandstone to sandy siltstone, generally laminated with some thin 2 to 5 cm thick siltier bioturbated layers.

Location: 031197E, 6585714N NAD83, Zone 10

Estimated age: Nammali

Figure 8. Sandstones near the base of the Toad Formation on the Alaska Highway south of Liard Hot Springs. Sample 14MBB003A01came from the bed behind the person.

Grayling Formation

Two samples of the sandstone from within 3 m of the base of the Grayling Formation (Figure 9, 10) were analysed from exposures in the western part of the basin (Figure 1, 2).

Field No. 14MBB027B01; GSC Curation No. C-591542; CAPPT lab number: UK015

Lithology: light brown weathering, light grey, very fine grained sand with the occasional mica flake; very thick to thick bedded locally with low angle lamination.

Location: 04366196E, 6525918N NAD83, Zone 10

Estimated age: Griesbachian

Figure 9. Sandstone at base of Grayling Formation sampled by sample 14MBB027B01.

Field No. 14MBB029A01; GSC Curation No. C-591544; CPATT lab number: UK020

Grey brown weathering, light grey, very fine grained sandstone, medium bedded, barely calcareous, weathers to rubble.

Location: 0355903E, 6603832N NAD83, Zone 10

Estimated age: Griesbachian

Figure 10. Sandstones at base of Grayling Formation. Sample 14MBB029A01came the rubbly sandstone intervals to the right and left of the sample bag.

DETRITAL ZIRCON U-PB AGE DETERMINATION METHODS

U-Pb isotopic data was collected by LA-ICP-MS methods. Seven samples were processed and measured at the Centre for Pure and Applied Tectonics and Thermochronology (CPATT), University of Calgary, Calgary, Canada (full details of the measurement method are presented in Matthews and Guest (2016)). Dates and probablity of concordance were calculated for each analysis using the Excel™ plug-in Isoplot v. 4.15 (Ludwig 2012). Measurements with a probability of concordance of less than 1% were eliminated from the dataset. The distribution of the 586 dates that met our filtering criteria are presented on a probability density plot (Figure 3).

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