Integration geoConvention 2013 geoscience engineering partnership

Dating the Doig: Conodonts Constrain the Age of the Doig Phosphate Zone in Northeastern British Columbia

Martyn Golding *, Department of Earth and Ocean Science, University of British Columbia, Vancouver, BC
mgolding@eos.ubc.ca

and

Mike Orchard, GSC Pacific, Vancouver, BC

J.-P. Zonneveld, Department of Earth and Atmospheric Science, University of Alberta, Edmonton, AB

Nick Wilson, Murphy Oil Corporation, Calgary, AB

Summary

Conodont samples from the subsurface of northeastern British Columbia allow the age of the boundary between the Montney and Doig formations in the Western Canada Sedimentary Basin to be determined, as well as the age and duration of the Doig Phosphate Zone. Initial study of conodonts collected from nine wells suggests that both the Montney-Doig boundary and the base of the Doig Phosphate Zone are diachronous. The Doig Formation has the potential to be an important source and reservoir rock for natural gas in British Columbia and Alberta, and therefore it is important to improve our understanding of the age, distribution and formation of the Doig Phosphate Zone.

Introduction

The Doig Formation of the Western Canada Sedimentary Basin has the potential to be an important source and reservoir rock for natural gas production in northeastern British Columbia and western Alberta. The lowest part of the formation is represented by an informal unit know as the Doig Phosphate Zone, which is characterized by an increased level of phosphatic material and can therefore be recognized both in core samples and on gamma-ray logs. The Doig Phosphate Zone occurs just above the Montney-Doig boundary, which is itself recognized by the appearance of a sharp firmground horizon that is burrowed by the *Glossifungites* ichnotaxon and overlain by phosphatic pebbles (Gibson and Barclay, 1989). Compared to the better known Monteny Formation, both the Doig Formation (which overlies the Montney) and the Doig Phosphate Zone are poorly understood. The Doig Formation contains siltstone and some sandstone, and it reaches a maximum thickness of around 450m in the Sukunka area, where it is difficult to distinguish from the overlying Halfway Formation (Edwards *et al.,* 1994). The unit thins to the east, before reaching an erosional edge at the margin of the basin. However, the age of the Montney-Doig boundary, and the age of the Doig Phosphate Zone, are not well constrained. The aim of this work has been to constrain the age of the Montney-Doig boundary as well as the age and the duration of the Doig Phosphate Zone using conodont biochronology.

Theory and/or Method

This problem has been approached by the collection of new conodont samples from nine wells in northeastern British Columbia, and comparison with existing collections from surface sections in British Columbia which are housed at the Geological Survey of Canada in Vancouver.

The wells that were sampled for this study were: Petro-Canada Kobes d-048-A/094-B-09; Petro-Canada Kobes c-074-G/094-B-9; Talisman Altares c-085-I/094-B-01; Talisman Altares 16-17-083-25W6; Arc Dawson 07-13-79-15W6; Murphy Swan d-054-B/093-P9; Talisman Groundbirch 03-06-078-22; Shell Groundbirch 16-02-078-22 and Shell Groundbirch 16-35-078-21. 83 samples were collected for conodont analysis. These were dissolved in dilute acetic acid and the residue sieved. The 90μm-850μm size fraction was retained and passed through 2.85 specific gravity sodium polytungstate. The heavy fraction was then picked underneath a light microscope and photographs were taken using a scanning electron microscope (SEM).

Previous collections were examined from the Alaska Highway and other surface localities in British Columbia. These samples are from the Toad and Liard formations, surface equivalents to the Montney and Doig formations. They were examined to aid in the identification of conodonts found in the new collections. The Lower and Middle Triassic conodont zones unique to North America were defined in British Columbia, the Canadian Arctic and the western USA (Mosher, 1968, 1973; Orchard and Tozer, 1997; Orchard and Zonneveld, 2008). Other zones were first identified in India (Orchard and Krystyn, 1998), Pakistan (Sweet *et al.,* 1971), China (Zhao *et al.,* 2007) and central Europe.

Fitting the samples into the conodont timescale allows the age of the Montney-Doig Boundary to be determined. If the boundary is isochronous then it should occur within the same conodont zone in each of the wells. Equally, if the Doig Phosphate Zone is of the same age throughout the basin then it should contain conodonts belonging to the same zones in each well.

Examples

The samples were taken from either side of the Montney-Doig boundary. The conodonts recovered range in age from the Smithian to the Anisian, and they belong to the following conodont zones: *meeki* Zone, *mosheri* Zone, *triangularis* Zone, *regale* Zone and *shoshonensis* Zone. The youngest conodonts found below the boundary belong to the *triangularis* Zone, which is Spathian, and are found in the Petro-Canada Kobes d-048-A/094-B-09 well. The oldest conodonts from above the boundary occur in the Talisman Altares 16-17-083-20W6 well and are from the *regale* zone, which is Anisian. The conodonts from within the Doig Phosphate Zone are not the same age in every section. For example, the Doig Phosphate Zone in the Murphy Swan d-054-B/093-P-9 well contains conodonts that are typical of the *shoshonensis* Zone, which is Middle Anisian, whilst in the Talisman Altares 16-17-083-20W6 well there are conodonts typical of the Lower Anisian, implying that the Doig Phosphate Zone is older in this well.

Conclusions

Conodont biostratigraphy suggests that the Doig Phosphate Zone is diachronous in northeastern British Columbia. Although the zone appears to be within the Anisian in all wells examined, its position within the stage varies. This evidence suggests that the Doig Phosphate Zone formed at different times in different areas, which has significance for the interpretation of this unit and its potential as source and reservoir rock. The Montney-Doig boundary is constrained to lie between the *triangularis* and *regale* zones in at least part of the study area, which is consistent with previous estimates of its age (e.g. Caplan, 1992; Qi, 1995; Zonneveld, 2010). The boundary is likely to be diachronous as well.

Acknowledgements

Thanks to Murphy Oil for allowing access to samples from the Talisman Groundbirch 03-06-078-22, Shell Groundbirch 16-02-078-22 and Shell Groundbirch 16-35-078-21 wells. Thanks to the staff of the Charlie Lake Core Facility in Fort St John for allowing access to core sections and for the preparation of samples. This work is funded in part by Geoscience BC.

References

Caplan, M.L., 1992, Sedimentology, stratigraphy and petrography of the Middle Triassic Halfway Formation, Peejay Field, northeastern British Columbia: Unpublished M.Sc. Thesis, 532p.

Edwards, D.E., Barclay, J.E., Gibson, D.W., Kvill, G.E. and Halton, E., 1994, Triassic Strata of the Western Canada Sedimentary Basin: *in* Geological Atlas of the Western Canada Sedimentary Basin, Mossop, G.D. and Shetsen, I. (eds.), Canadian Society of Petroleum Geologists and Alberta Research Council Special Report 4.

Gibson, D.W. and Barclay, J.E., 1989, Middle Absaroka Sequence – the Triassic stable craton: *in* Western Canada Sedimentary Basin, A Case History, Ricketts, B.D. (ed.), Canadian Society of Petroleum Geologists, 219-231.

Mosher, L.C., 1968, Triassic conodonts from western North America and Europe and their correlation: Journal of Paleontology, **42**, 895-946.

Mosher, L.C., 1973, Triassic conodonts from British Columbia and the northern Arctic Islands: Geological Survey of Canada, Bulletin 222, 141-193.

Orchard, M.J. and Krystyn, L., 1998, Conodonts of the lowermost Triassic of Spiti, and new zonation based on *Neogondolella* successions: Rivista Italiana di Paleontologia e Stratigrafia, **104**, 341-368.

Orchard, M.J. and Tozer, E.T., 1997, Triassic conodont biochronology, its calibration with the ammonoid standard, and a biostratigraphic summary for the Western Canada Sedimentary Basin: Bulletin of Canadian Petroleum Geology, **45**, 675-692.

Orchard, M.J. and Zonneveld, J.-P., 2008, The Lower Triassic Sulphur Mountain Formation in the Wapiti Lake area: lithostratigraphy, conodont biostratigraphy, and a new biozonation for the lower Olenekian (Smithian): Canadian Journal of Earth Science, **46**, 757-790.

Qi, F., 1995, Seismic stratigraphy and sedimentary facies of the Middle Triassic strata, Western Canada Sedimentary Basin, northeastern British Columbia: Unpublished PhD Thesis, 219p.

Sweet, W.C., Mosher, L.C., Clark, D.L., Collinson, J.W. and Hansenmueller, W.A., 1971, Conodont biostratigraphy of the Triassic: Geological Society of America, Memoir 127, 441-465.

Zhao, L., Orchard, M.J., Tong, J., Sun, Z., Zuo, J., Zhang, S. and Yun, A., 2007, Lower Triassic conodont sequence in Chaohu, Anhui Province, China and its global correlation: Palaeogeography, Palaeoclimatology, Palaeoecology, **252**, 24-38.

Zonneveld, J.-P., 2010, The Triassic of northeastern British Columbia: Sedimentary characteristics and stratigraphic architecture of conventional and unconventional reservoir successions: Williston Lake Field Trip Guidebook, GeoCanada 2010.