U-Pb zircon ages of the Flemish Cap: Potential sources of detritus to Mesozoic sedimentary basins of the North Atlantic conjugate margin

PAUL SYLVESTER & KATE SOUDERS

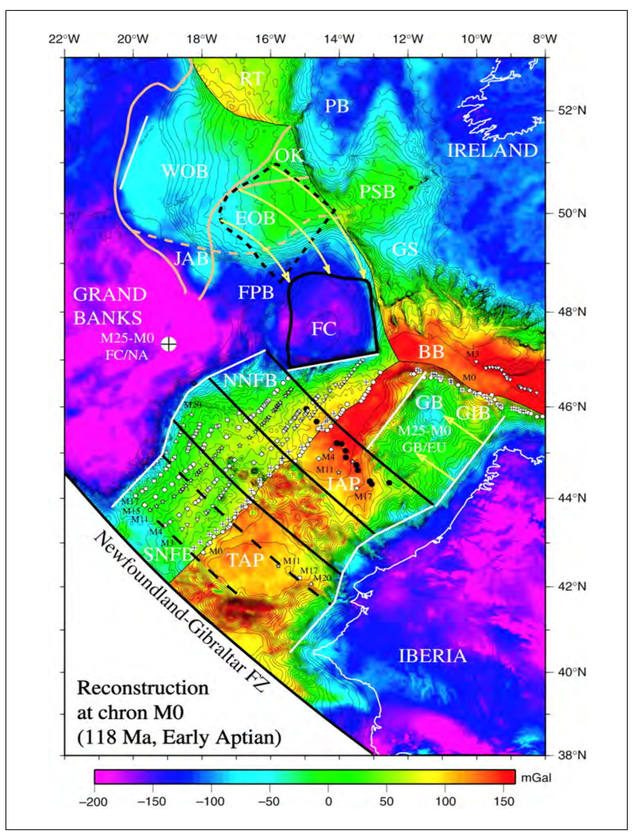
Department of Geosciences, Texas Tech University, Lubbock TX USA

Paul.Sylvester@ttu.edu; Kate.Souders@ttu.edu

Introduction

Petroleum exploration of the offshore deep-water basins of the Ireland – Newfoundland conjugate margin (Williams et al. 1999) is expensive and risky. Improved knowledge of the regional geology of the offshore allows more effective evaluation of the hydrocarbon potential of the region. An aspect of the offshore geology that is particularly poorly known is the nature and geological history of basement uplifts and their contributions to the supply of sedimentary detritus to source and reservoir units in the basins. Recent work has suggested that basement highs in the North Atlantic may have been important sources of sediment to offshore basins during the Mesozoic (Evans-Young, 2014; Tyrrell et al., 2007, 2010). The ages and compositions of the basement highs are therefore relevant to understanding the development of the sedimentary basins. U-Pb zircon ages for a granodiorite from a core taken from the central part of the Flemish Cap are strongly discordant (King et al. 1985), however, so that the correlation with Avalon granitoids has remained speculative.

Flemish Cap Geology



The Flemish Cap (FC; Fig. 1) is a large, 150 km-wide, circular, isolated submarine knoll 600 km east of Newfoundland. Drill core samples from the central and southern edge of the knoll suggest that the major basement lithology is granodiorite with chemical affinities similar to the ca. 600 Ma subduction-related plutons of the Avalon terrane of Newfoundland and Nova Scotia (Pe-Piper 1992).

Fig. 1: Plate reconstruction of the North Atlantic and Bay of Biscay (BB) at ~118 Ma. The Flemish Cap (FC) is outlines in black. Colors are crustal Bouguer anomalies and bathymetric contours are shown in black. Black dots are IPOD and ODP holes. FPB = Flemish Pass Basin; GB = Galicia Bank; GS = Goban Spur; IAP = Iberian Abyssal Plain; JAB = Jeanne d'Arc Basin; NNFB and SNFB = north and south Newfoundland Basins; GIB = Galicia Interior Basin; EOB and WOB = East and West Orphan Basins; OK = Orphan Knoll; PB = Porcupine Bank; PSB = Porcupine Seabight Basin; RT = Rockall Trough; TAP = Tagus Abyssal Plain. From Enachescu (2005) and references therein.

Samples

We determined the U-Pb zircon ages of 3 granodiorite samples (Fig. 2) collected from the surface of the southern edge of the Flemish Cap by the Canadian scientific vessel CCGS Hudson using the remotely operated submersible vehicle ROPOS in 2010. Subsurface images from the submersible vehicle indicate that the Carboniferous sample site represents in-place bedrock and the Paleoproterozoic sample probably does. The Archean sample is most probably ice-rafted debris as it was sampled from a flat area on the knoll covered in sediment.

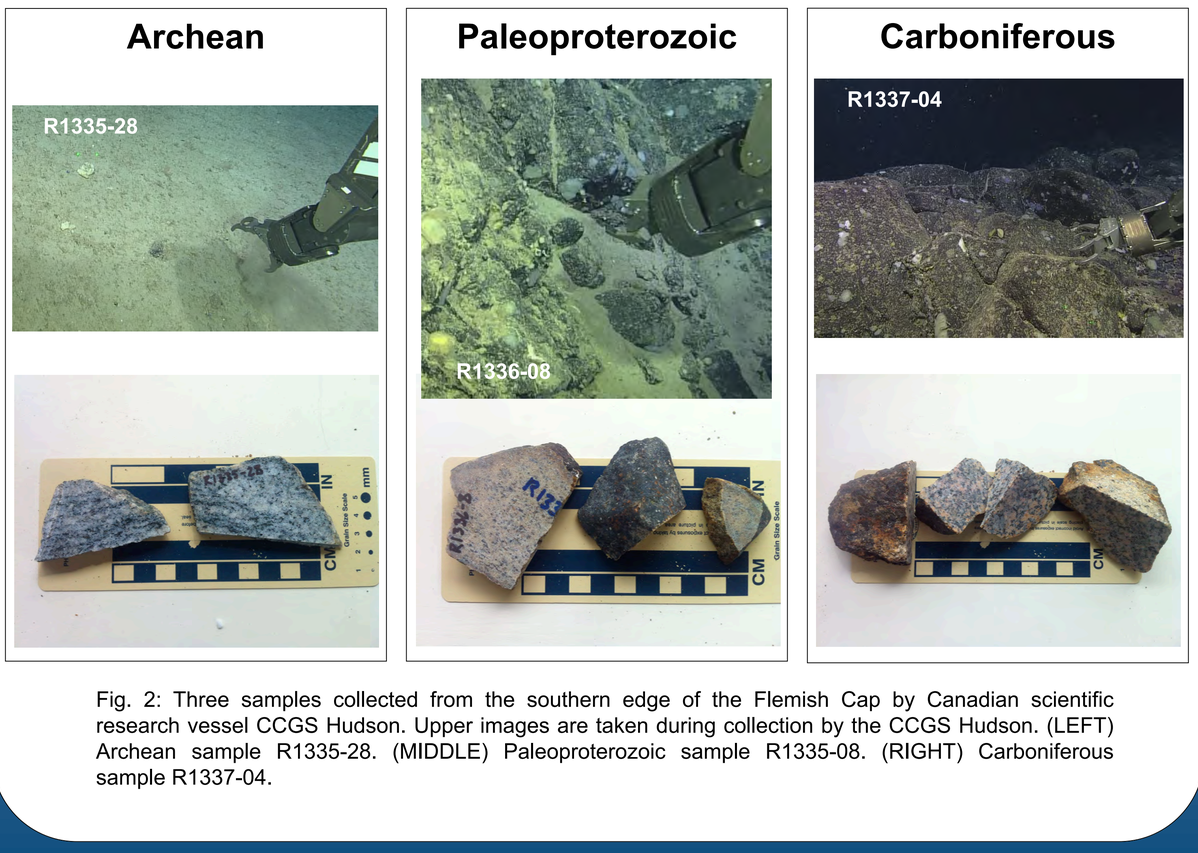


Fig. 2: Three samples collected from the southern edge of the Flemish Cap by Canadian scientific research vessel CCGS Hudson. Upper images are taken during collection by the CCGS Hudson. (LEFT) Archean sample R1335-28. (MIDDLE) Paleoproterozoic sample R1335-08. (RIGHT) Carboniferous sample R1337-04.

Results

Laser ablation-ICPMS measurements for U-Pb isotopes were made on inclusion- and fracture-free regions of the zircon grains. Analyses were carried out using a Nu Instruments AttoM ICPMS coupled to a Photon Machines 193 nm ArF Excimer laser at the USGS in Denver, CO. U-Pb age measurements were taken using a 30 µm x 30 µm box raster of the laser beam on discrete domains in the zircon grains identified from BSE images using a fluence of 4.72 J/cm^2, repetition rate of 7 Hz, a 10 µm laser beam, and a scanning rate of 10 µm/sec. Data were processed using UranOS data reduction program (v. 2.02; Dunkl et al. 2014).

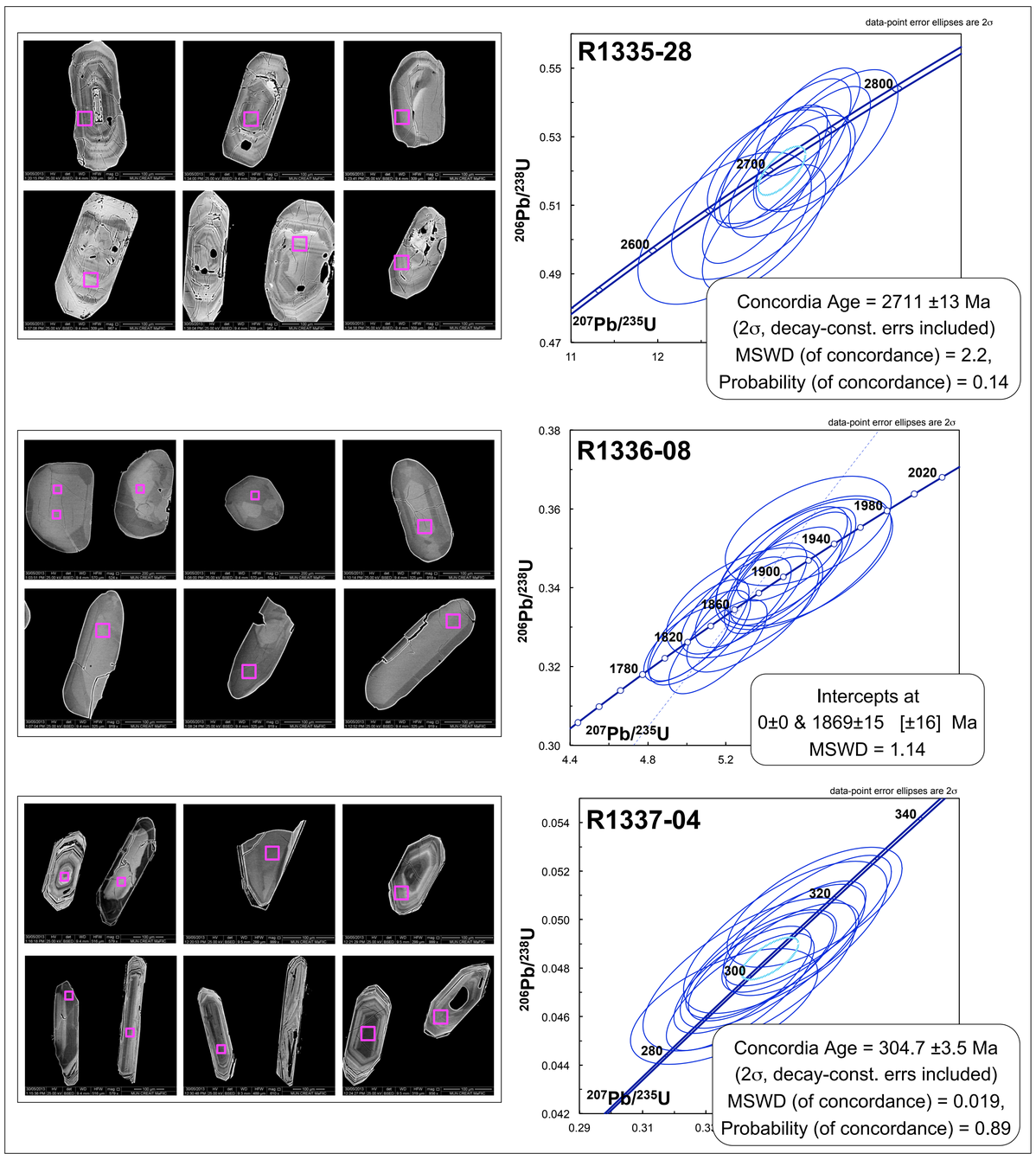


Fig. 3: Representative BSE images and U-Pb ages for zircon grains from the 3 samples collected from the Flemish Cap. Pink boxes on the BSE images mark the 30 µm x 30 µm U-Pb analysis location for each zircon crystal.

Conclusions

The results indicate that the Flemish Cap granodiorites could have provided a local source of detritus with at least Carboniferous and Paleoproterozoic ages to nearby sedimentary basins during the Mesozoic. Long-distance paleodrainage routes from distal, Carboniferous Variscan and Paleoproterozoic Makkovik/Ketilidian terranes were not required.

Acknowledgements

This project was funded by the Research & Development Corporation of Newfoundland & Labrador, Nalcor Energy Oil & Gas, and the Irish Shelf Petroleum Studies Group (ISPSG) of the Irish Petroleum Infrastructure Programme (PIP) Group 4. David Piper & Shawn Meredyk provided the samples.

References

(1) Dunkl, T., Mikes, T., Frei, D., Gerdes, A., Tolosana-Delgado, R., von Eynatten, H. 2014. UranOS: data reduction program for time-resolved U/Pb analyses (*v. 2.02;* www.sediment.uni-goettigen.de/staff/dunkl/software) (2) Enachescu, M., 2005. Regional setting, representative transects and petroleum potential of the Orphan Basin, offshore Newfoundland and Labrador. (3) Evans-Young, S., Shannon, P.M., Tyrrell, S., Naylor, D. & Daly, J.S. 2014. The provenance and petrography of Early Tertiary sandstones in the northeast Porcupine Basin. Abstracts to the 4th Atlantic Conjugate Margins Conference, 202-204. (4) King, L. H., Fader, G. B., Poole, W. H., & Wanless, R. K. 1985. Geological setting and age of the Flemish Cap granodiorite, east of the Grand Banks of Newfoundland. Canadian Journal of Earth Sciences, 22(9), 1286-1298. (5) Pe-Piper, G., 1992. Geochemistry of late Proterozoic plutonic rocks from Flemish Cap, east of the Grand Banks of Newfoundland. In: Current Research, Part D; Geological Survey of Canada, Paper 92-1D, 45-48. (6) Tyrrell, S., Souders, A.K., Haughton, P.D.W., Daly, J.S. & Shannon, P.M. 2010. Sandstone provenance and palaeodrainage on the eastern Rockall Basin margin: evidence from the Pb isotopic composition of detrital K-feldspar. In: Vining, B. & Pickering S.C., (eds.); From Mature Basins to New Frontiers: Proceedings of the 7th Petroleum Geology Conference. 937-952. (7) Tyrrell, S., Haughton, P.D.W. and Daly, J.S., 2007. Drainage re-organization during break-up of Pangea revealed by in-situ Pb isotopic analysis of detrital K-feldspar. Geology, 35, 971-974. (8) Williams, B.P.J., P.M. Shannon and I.K. Sinclair, 1999. Comparative Jurassic and Cretaceous tectono-stratigraphy and reservoir development in the Jeanne d'Arc and Porcupine basins. In: Fleet, A. J. & Boldy, S. A. R. (eds) Petroleum Geology of Northwest Europe: Proceedings of the 5th Conference, 487-499.