From the British Caledonides to Sudbury: A review of Bill Morris' career

Hernan Ugalde ***(no Bill, you are <u>not</u> in this one)***
Brock University

Intro

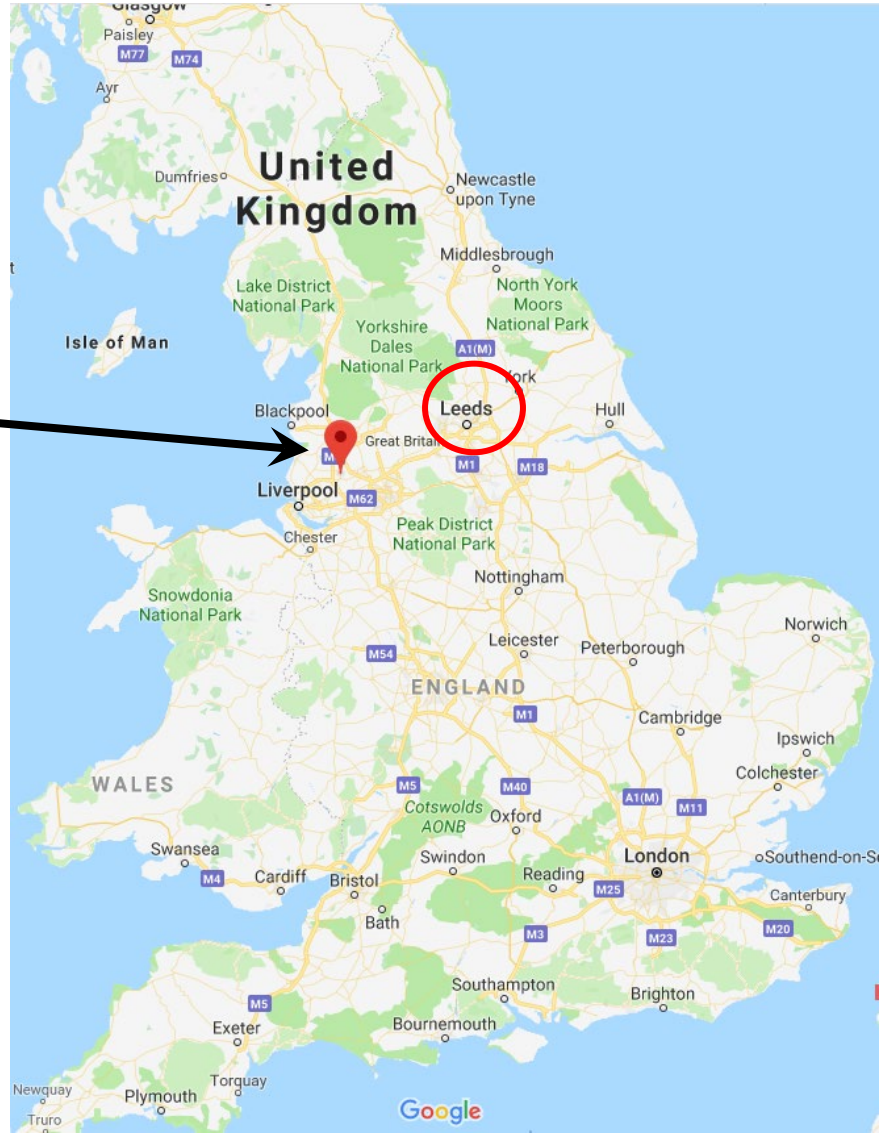
Professor William A. Morris, WAM, Bill, Billiam, The Morrasaurus Rex (as told to the students in field camp, upon discovering a paleomag hole).

Trying to summarize his career in 15 minutes is not minor task, but at least I have some of the co-culprits here in the audience…let's give it a try…

Early Days

I am not going to start that far back, but let's just say that Bill comes from Wigan. From there, he pursued a B.Sc. in Earth Sciences at the University of Leeds in 1970 (B.D.F.)*

Wigan



*before Derek Fairhead

Graduate Studies

From Leeds, Bill went on to pursue a Ph.D. in Earth Sciences at Open University (1970-1974).
The Open University was established in 1969, and Bill was among the first students to get enrolled, and I think one of the first Geology graduates (if not the first).

Let's just say that Bill was quite busy swiss-cheesing the British Isles, and having fun with stereonets.

Briden, J.C. and **Morris, W.A.**, 1973.
Palaeomagnetic studies in the British Caledonides II: The Northern Lake District.
Geophysical Journal of the Royal Astronomical Society, v.34, p.27 - 47.

Morris, W.A., Briden, J.C., Piper, J.D.A., and Sallomy, J.T., 1973.
Palaeomagnetic studies in the British Caledonides V: Miscellaneous new data.
Geophysical Journal of the Royal Astronomical Society, v.34, p.69 - 107.

Briden, J.C., **Morris, W.A.**, and Piper, J.D.A., 1973.
Palaeomagnetic studies in the British Caledonides VI: Regional and global implications.
Geophysical Journal of the Royal Astronomical Society, v.34, p.107 - 135.

Welcome to Canada

In 1973 Bill landed in London…ON, as a postdoc with C.M. Carmichael at University of Western Ontario (1973-1975)

…and the MAGGIC had begun already!

Paleomagnetic results from the Lower Paleozoic of Ireland

W. A. MORRIS

Department of Geophysics, University of Western Ontario, London, Ontario

Received 24 December 1974

Revision accepted for publication 16 October 1974

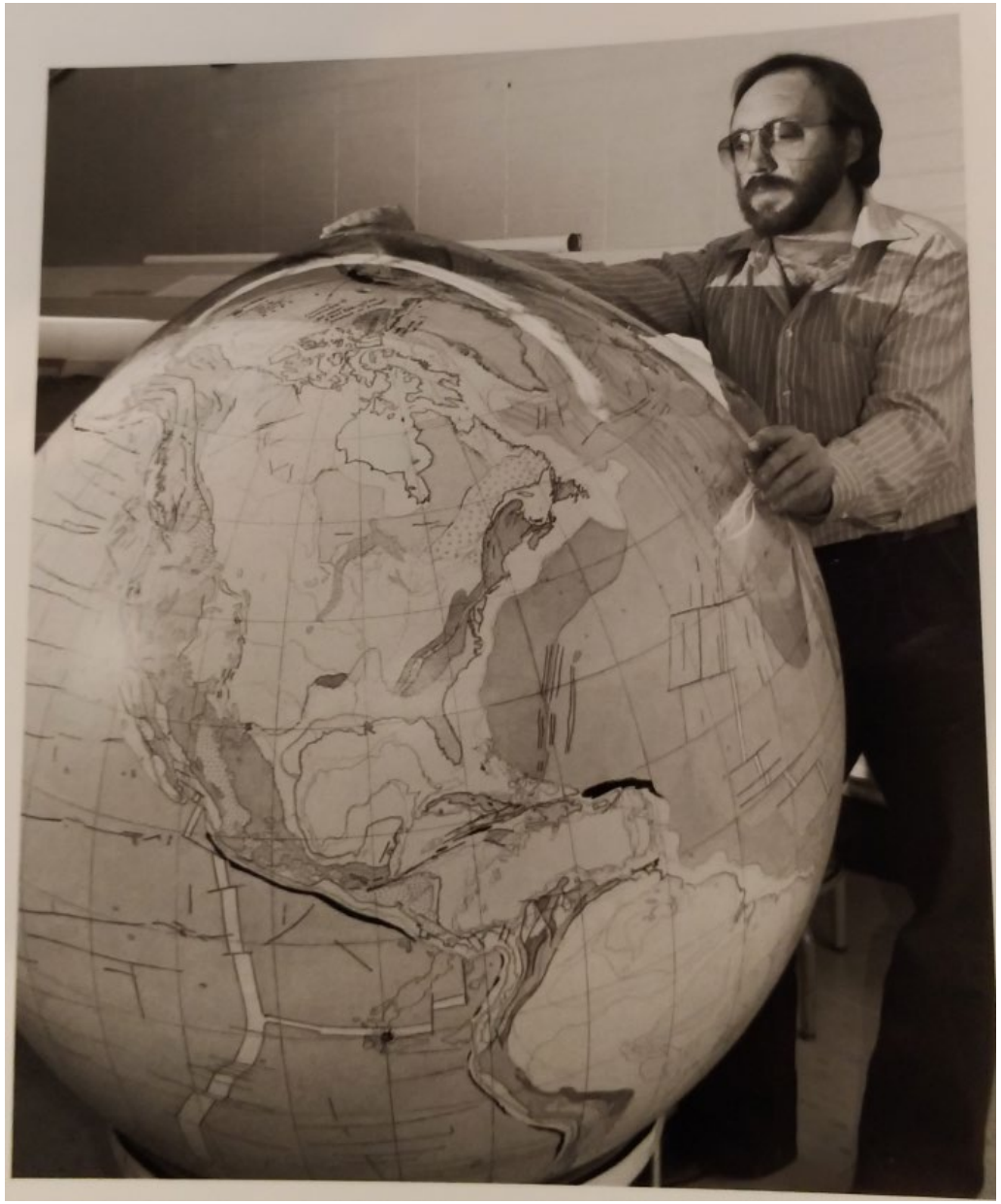
Paleomagnetic data are presented for a variety of Ordovician rocks from two regions in Ireland: the South Mayo Trough and some Ordovician inliers of east-central Ireland. Some of these data update previous preliminary results, while others provide new information. In some instances the original remanence direction has been obscured by subsequent remagnetization.

Although magnetic inclinations of the Ordovician results are mostly shallower than contemporaneous British results, poor precision precludes any reliable estimate of closure across this sector of the Proto-Atlantic ocean. Declination differences between the South Mayo Trough and British data indicate a 30° clockwise rotation of this tectonic block during the Middle to Upper Devonian.

First stint in Ottawa

Post-Doctorate Fellow, Earth Physics Branch, Energy, Mines and Resources Canada, Ottawa, Ontario, 1975 - 1977.

Supervisors: Dr. E. Irving, and Mr. J.L. Roy.



First stint in Ottawa

This PDF time in Ottawa was quite productive, finishing paleomag work in Ireland, and going from the Rapitan (NWT) to Chibougamau (Quebec), the Grenville, Superior Province, and goes on, and on, and on….

5. **Morris, W.A**., 1976.
Transcurrent fault motion determined paleomagnetically and the age of the Acadian orogeny.
Canadian Journal of Earth Sciences, v.13, p.1236 - 1243.

6. **Morris, W.A**., 1977.
Paleolatitude of glaciogenic upper Precambrian Rapitan group and the use of tillites as chronostratigraphic marker horizons.
Geology, v.5, p.84 - 88.

7. **Morris, W.A**., 1977.
Paleomagnetism of the Gowganda and Chibougamau: Evidence of a 2,200 my. old folding and remagnetization event in the Southern Province.
Geology, v.5, p.137 - 140.

8. Faller, A.M., Briden, J.C. and **Morris, W.A**., 1977.
Paleomagnetic results from the Borrowdale Volcanic Group, English Lake District.
Geophysical Journal of the Royal Astronomical Society, v.48, p.111 - 121.

9. **Morris, W.A**. and Roy, J.L., 1977.
Discovery of the Hadrynian Polar Track and further study of the Grenville problem.
Nature, v.266, p.689 - 692.

10. **Morris, W.A**. and Tanner, P.W.G., 1977.
The use of paleomagnetic data to delineate the history of the development of the Connemara Antiform.
Canadian Journal of Earth Sciences, v.14, p.2601 - 2613.

11. Schmidt, P.W. and **Morris, W.A**., 1978.
An alternative Paleozoic polar wander path for Gondwanaland.
Canadian Journal of Earth Sciences, v.14, p.2674 - 2678.

First stint in Ottawa

Africa, Superior and Slave Provinces, back to Ireland, Huronian Supergroup, etc.

Still mostly paleomag, and no signs of Sudbury yet….early days.

12. **Morris, W.A**. and Carmichael, C.M., 1978.
Paleomagnetism of some late Precambrian sediments from "l'Adrar de Mauritanie", West Africa, and its bearing on the Pan-African orogeny.
Canadian Journal of Earth Sciences, v.15, p.253 - 262.

13. Roy, J.L., **Morris, W.A**., Lapointe, P., Schmidt, P.W., Irving, E. and Park, J.K., 1978.
Apparent polar wander paths and the joining of the Superior and Slave provinces during early Proterozoic time: Comment.
Geology, v.6, p.132 - 133.

14. **Morris, W.A.**, 1978.
Paleolatitude of glaciogenic upper Precambrian Rapitan Group and the use of tillites as chronostratigraphic marker horizons: Reply to G.E. Williams.
Geology, v.6, p.65.

15. Lapointe, P.L., Roy, J.L. and **Morris, W.A**., 1978.
What happened to the high latitude paleomagnetic poles?
Nature, v.273, p.655 - 657.

16. Piper, J.D.A., McCook, A.S., Watkins, K.P., Brown, G.C., and **Morris, W.A**., 1978.
Paleomagnetism and chronology of Caledonian igneous episodes in the Cross Fell Inlier and Northern Lake District.
Geological Journal, v.13, p.73 - 92.

17. **Morris, W.A**. and Tanczyk, E.I., 1978.
Precambrian dykes: a preferred orientation of intrusion.
Nature, v.275, p.120 - 121.

18. Max, M.D., Kelly, T.J. and **Morris, W.A**., 1978.
The Maumtrasna Group problem: possible Devonian rocks in Murrisk, Western Ireland.
Journal of Earth Sciences of the Royal Dublin Society, v.1, p.115 - 119.

19. **Morris, W.A.**, Schmidt, P.W. and Roy, J.L., 1979.
A graphical approach to polar paths, paleomagnetic cycles and global tectonics.
Physics of Earth and Planetary Interiors, v.19, p.85 - 99.

20. **Morris, W.A.**, 1979.
A positive contact test between Nipissing diabase and Gowganda argillite.
Canadian Journal of Earth Sciences, v.16, p.607 - 611.

22. **Morris, W.A.**, Schmidt, P.W. and Roy, J.L., 1979.
Reply to An 'unconventional' Proterozoic paleomagnetic polar wander path for North America, and its advantages.
Physics of Earth and Planetary Interiors, v.20, p.71 - 73.

1977-1990: Morris Magnetics Inc

That must have been a sign. Decided to embrace “global” magnetics instead of just paleomag (the legend says that one candidate name for MMI was “Paleo Magnetic Services”…).

And here we go ballistic: Borehole Geophysics, more general geophysics rather than just focus on paleomag, and Bill keeps on publishing. Probably the eureka moment:

OTHER | APRIL 01, 1980

Tectonic and metamorphic history of the Sudbury norite; the evidence from paleomagnetism

W. A. Morris

Economic Geology (1980) 75 (2): 260-277.

https://doi.org/10.2113/gsecongeo.75.2.260

1977-1990: Morris Magnetics Inc

And please keep in mind that at this time Bill is working as a consultant…

31. **Morris, W.A.**, 1982.
A paleomagnetic investigation of the Sudbury Basin Offsets, Ontario, Canada.
Tectonophysics, v.85, p.291 - 312.

32. **Morris, W.A.** and Aitken, J.D., 1982.
Paleomagnetism of the Little Dal Lavas, Mackenzie Mountains, Northwest Territories, Canada.
Canadian Journal of Earth Sciences, v.19, p.2020 - 2027.

33. Van der Voo, R. and **Morris, W.A.**, 1982.
A short note on early Cambrian paleomagnetism from Normandy, France.
Geophysical Journal of the Royal Astronomical Society, v.68, p.269-271.

24. Max, M.D., Kelly, T.J. and **Morris, W.A.**, 1980.
Reply to discussion of: The Maumtrasna Group problem: possible Devonian rocks in Murrisk.
Journal of Earth Sciences of the Royal Dublin Society, v.3, p.114 - 115.

25. **Morris, W.A.**, 1980.
Paleomagnetism of Lower Cambrian red beds from Cartaret, France.
Geophysical Journal of the Royal Astronomical Society, v.62, p.577 - 590.

26. **Morris, W.A.**, 1981.
A positive fold test in Nipissing diabase.
Canadian Journal of Earth Sciences, v.18, p.591 - 598.

27. **Morris, W.A.**, 1981.
The intrusive and tectonic history of the Sudbury micropegmatite: the evidence from paleomagnetism.
Economic Geology, v.76, p.791 - 804.

28. **Morris, W.A.**, 1981.
Paleomagnetism of some sulphide occurrences from the South Range of the Sudbury Basin.
Journal of the Canadian Society of Exploration Geophysicists, v.17, p.55 - 71.

29. **Morris, W.A.**, 1981.
Fault block rotations in the Southern Province as defined by paleomagnetism of the Nipissing diabase.
Canadian Journal of Earth Sciences, v.18, p.1755 - 1757.

30. **Morris, W.A.** and Pay, R.M., 1981.
Genesis of the Foy Offset and its sulphide ores: The paleomagnetic evidence from a study in Hess Twp., Sudbury, Ontario.
Economic Geology, v.76, p.1895 - 1905.

31. **Morris, W.A.**, 1982.
A paleomagnetic investigation of the Sudbury Basin Offsets, Ontario, Canada.
Tectonophysics, v.85, p.291 - 312.

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Tectonophysics, v.85, p.291 - 312.

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Canadian Journal of Earth Sciences, v.19, p.2020 - 2027.

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Geophysical Journal of the Royal Astronomical Society, v.68, p.269-271.

34. **Morris, W.A.** and McMechan, M., 1983.
Paleomagnetism of the Mount Nelson Formation, southern British Columbia, and the correlation of the Belt Series.
Canadian Journal of Earth Sciences, v.20, p.561 - 567.

35. Roy, J.L. and **Morris, W.A.**, 1983.
A review of paleomagnetic results from the Carboniferous of North America; the concept of Carboniferous geomagnetic field horizon markers.
Earth and Planetary Science Letters, v.65, p.167 - 181.

36. Clark, D.L., Vincent, J. S., Jones, G.A., and **Morris, W.A.**, 1984.
Contemporaneous Marine and Continental Glacial and Interglacial events, Canadian Arctic Archipelago and Central Arctic Ocean.
Nature, v.311, p.147 - 149.

37. Lapointe, P., Chomyn, B.A., **Morris, W.A.** and Coles R.L., 1984.
Significance of magnetic susceptibility measurements from the Lac du Bonnet Batholith, Manitoba, Canada.
Geoexploration, v.22, p.217 - 229.

38. **Morris, W.A.**, Vincent, J-S., and Occhietti, S., 1984.
Glacial and non-glacial sediments of Matuyama paleomagnetic age on Banks Island, Canadian Arctic Archipelago.
Geology, v.12, p.139 - 142.

39. Lapointe, P., **Morris, W.A.**, and Harding, K.L., 1986.
Interpretation of magnetic susceptibility: a new approach to geophysical evaluation of the degree of rock alteration.
Canadian Journal of Earth Sciences, v.23, p.393 - 401.

1977-1990: Morris Magnetics Inc

Some of the work from this period:

- Sudbury (I will let Bill give us the works after I finish arm waving here)
- Rock properties: effects of alteration on magnetic susceptibility. This has been a constant on Bill's research. He gave a presentation on this not too long ago, at SAGA in 2017
- Conducting ground magnetic surveys over frozen lakes: led to some early ideas on the topographic effects on magnetic data.

1990-2015: McMaster University

This marked the more definite shift from paleomag to geophysics, remote sensing and everything he could get his sticky fingers on.
Perhaps the main legacy from these McMaster days is that every single student got snatched by the industry right away.

Many of the names are here, but the following list is a summary of some of the graduate students (add the undergrads, and a few more)

1990-2015: McMaster University

E.I. Tanczyk, M.Sc., Carleton University, Ottawa, 1974 - 1976.
Do Precambrian dykes exhibit a preferred orientation of intrusion?
Occupation: Research Scientist, Federal Government.

B.A. Chomyn, M.Sc., Carleton University, Ottawa, 1975 - 1977.
Association of magnetic property changes with fracture zones in large granite plutons.
Occupation: Environmental Lawyer, Ottawa.

R.B. Hearst, M.Sc., McMaster University, Hamilton, 1991 - 1996.
Geophysical anomaly modelling of the deep structure of the Sudbury Structure.
Occupation: Geophysicist, Stratagex, Toronto.

J. K. Versteeg, M.Sc., McMaster University, Hamilton, 1991 - 1994.
The characterisation and distribution of contaminated sediments in Hamilton Harbour, as determined by magnetic property analysis.
Occupation: Senior Geophysicist, Paterson, Grant & Watson Inc., Toronto.

J. E. Clougherty, M.Sc., McMaster University, Hamilton, 1997 – 1998.
Diurnal patterns in air pollution.
Occupation: Research Assistant, Chicago University.

G.E. LeBlanc, Ph.D., McMaster University, Hamilton, 1995 - 1999.
Application of wavelet transform to analysis of aeromagnetic data for oil and mineral exploration
Occupation: Research Scientist, National Aeronautic Establishment, Ottawa.

K. J. Markham. M.Sc. McMaster University, Hamilton, Ontario, 1999 – 2001.
Methods for producing digital terrain elevation models: Analysis, comparison & integration with geophysical data.
Occupation: Ph.D. student, McMaster University

S.E. Manning, Ph.D., McMaster University, Hamilton, 1995 - 2003.
Classification and prediction analysis of physical rock property data from downhole geophysical surveys.
Occupation: Geophysicist, Viewlog systems, Toronto.

V. L. Thomson, M.Sc. McMaster University, Hamilton, 2001 – 2004.
Integration of hyperspectral imagery and airborne aeromagnetic data from Cuprite, Nevada
Occupation: Geophysicist Teck Resources, Vancouver

J. Shang, Ph.D. Waterloo University, Waterloo, Ontario, 2000- 2005.
Hyperspectral imaging of mine tailings; The Copper Cliff site, Sudbury, Ontario
Occupation: Research Scientist Agriculture Canada

J. Wallace, Ph.D. Waterloo University, Waterloo, Ontario, 2001-2005
Integration of hyperspectral and LIDAR imagery for acid rock drainage monitoring
Occupation: Research Associate School of Geography & Earth Sciences

H. Slavinski, M.Sc. McMaster University, Hamilton, Ontario, 2005-2007
Integration of geophysical and geological data for mineral prospecting
Occupation: Geophysicist, Exxon, Calgary, Alberta.

1990-2015: McMaster University

SEG 1991

Rock Magnetic Properties: Why Bother?

Robert B. Hearst, Paterson, Grant and Watson Ltd./McMaster Univ.; and William A. Morris, McMaster Univ., Canada*

1983; Morris et al, 1984). Preliminary modelling of the magnetic data sets assuming only induced magnetization illustrated the difficulty of arriving at a magnetic source geometry consistent with the mapped surficial and borehole geology (Reeves, 1983). Integration of the magnetic rock properties observations with industry standard magnetic modelling techniques provides a source model geometry that is consistent with other geophysical/geological data sets, e.g. gravity and observed geology. The genesis of individual magnetic signatures in the East Bull Lake gabbro-anorthosite record the intrusion, metamorphism and fracture alteration of the pluton. As shown by this example, only by understanding the rock magnetic signatures associated with each of these events is it possible to obtain geologically meaningful interpretative models.

GRL 1994

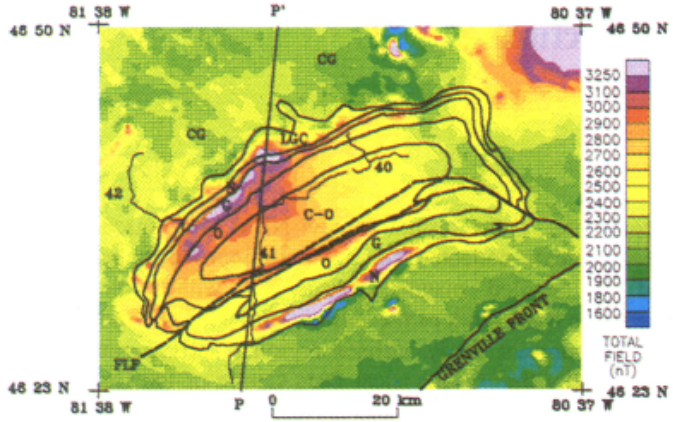


Fig. 1. Total magnetic field map. Abbreviations for geological units: CG, Cartier Granite; LGC, Levack Gneiss Complex; N, Norite; G, Granophyre; O, Onaping Formation; C-O, Chelmsford & Onwatin Formations (Whitewater Group). P-P' is model profile trace. Lithoprobe seismic profiles are numbered 40, 41, & 42.

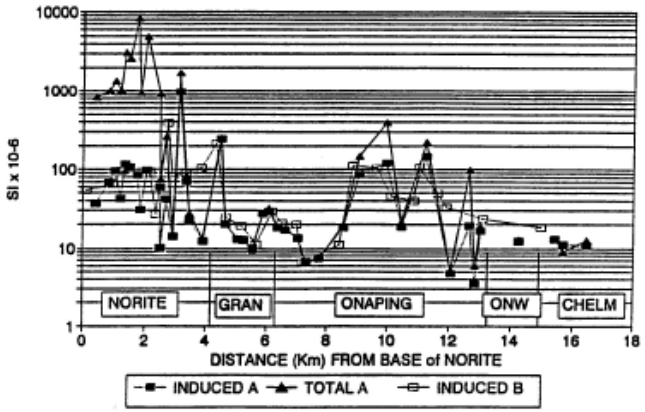


Fig. 2. Variations of induced field A and total magnetic field A calculated from laboratory measurement of specimens and induced field B derived from in-situ magnetic susceptibility measurements along the Lithoprobe Transect 41 across the South Range of the Sudbury Structure. Distances are along the actual route of the Transect (Figure 1), 0 marks the south contact of the SIC.

A continuous drive for using physical rock properties for the interpretation and modelling of geophysical data. As usual, aiming at producing geological models.

Early magnetic & gravity models of the Sudbury basin. Separating units by their physical properties

1990-2015: McMaster University

SEG 1995

A 3-D model of the Sudbury Igneous Complex

Edna L. Mueller and William A. Morris, McMaster University, Canada*

SUMMARY

In this paper we use 3-Dimensional modelling to try to constrain the geometry of the norite "floor" of the Sudbury Igneous Complex of the Sudbury Structure. This has been achieved by constructing a model of cubes. Each cube has its own unique properties of density, susceptibility, and natural remanent magnetization. The presented model consists of an asymmetrical basin in which the South Range units dip steeply to the south. The continuation of the North Range units under the centre of the Sudbury Basin is the aspect in which this model differs from many recent models. Rather than a continous dipping sheet, a deformed norite "floor" is used. This deformation allows the norite "floor" to be displaced upwards. An examination of the model's gravity and magnetic fields with the measured residual gravity and magnetic fields show some similarities. The outline of the anomalies seems to be, for the most part, caused by the geological units seen at the the surface. However, a linear magnetic anomaly along the South Range Onaping - Onwatin contact can be explained by a remanece constrast of these two geological units. A local gravity high seen in the Centre of the Chelmsford formation can be accounted for by the upthrusted norite "floor".

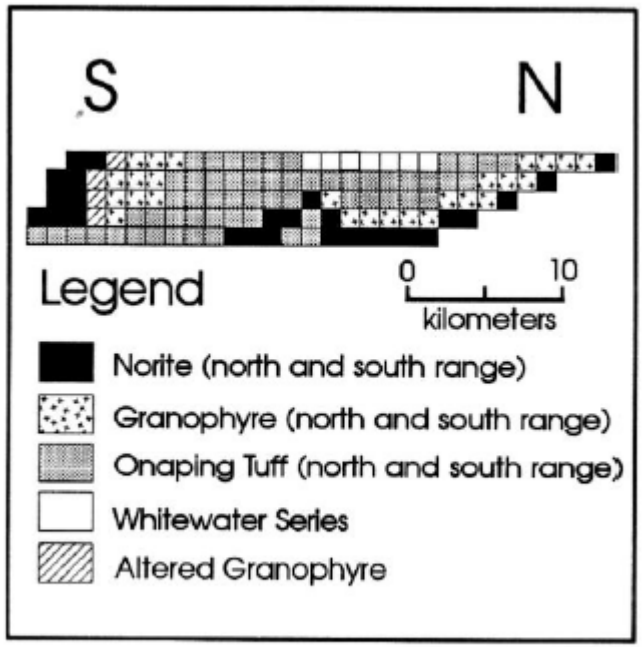


Figure 1. Cross-section through centre of Sudbury Igneous Complex

We are in 1995, before UBC and VOXI, and this code was able to deal with magnetics (susceptibility AND remanence) and gravity

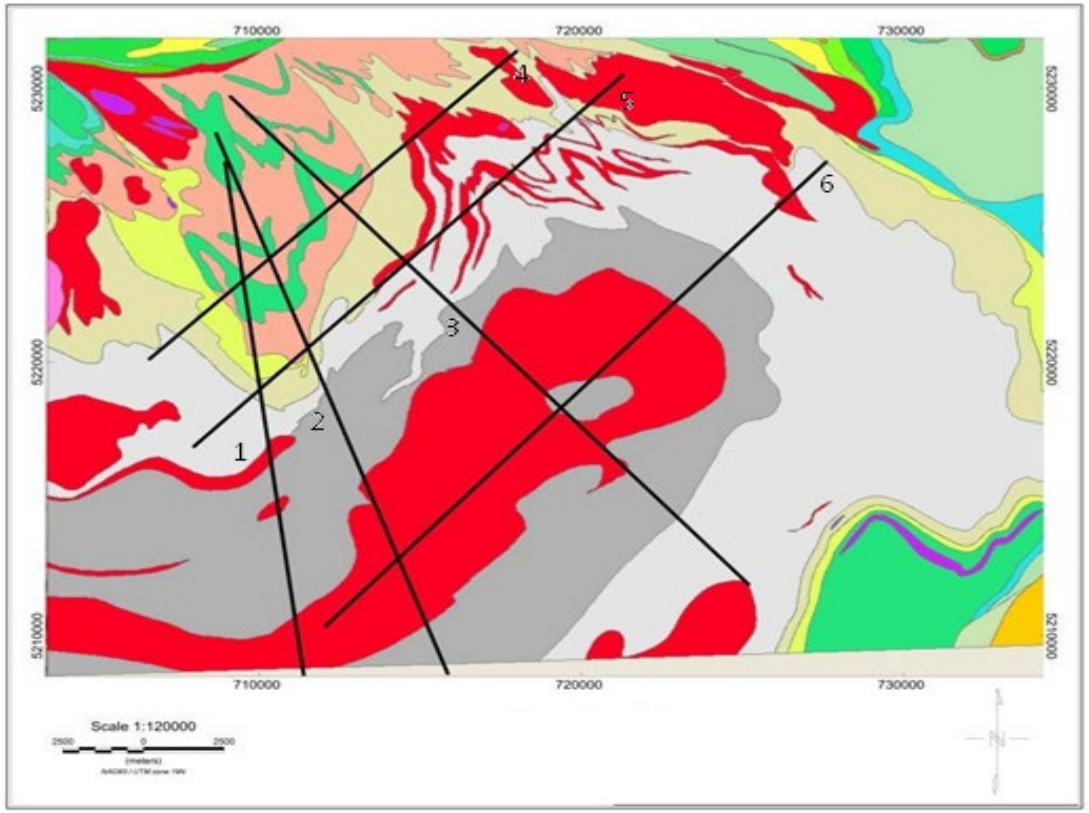
1990-2015: McMaster University, the MAGGIC lab

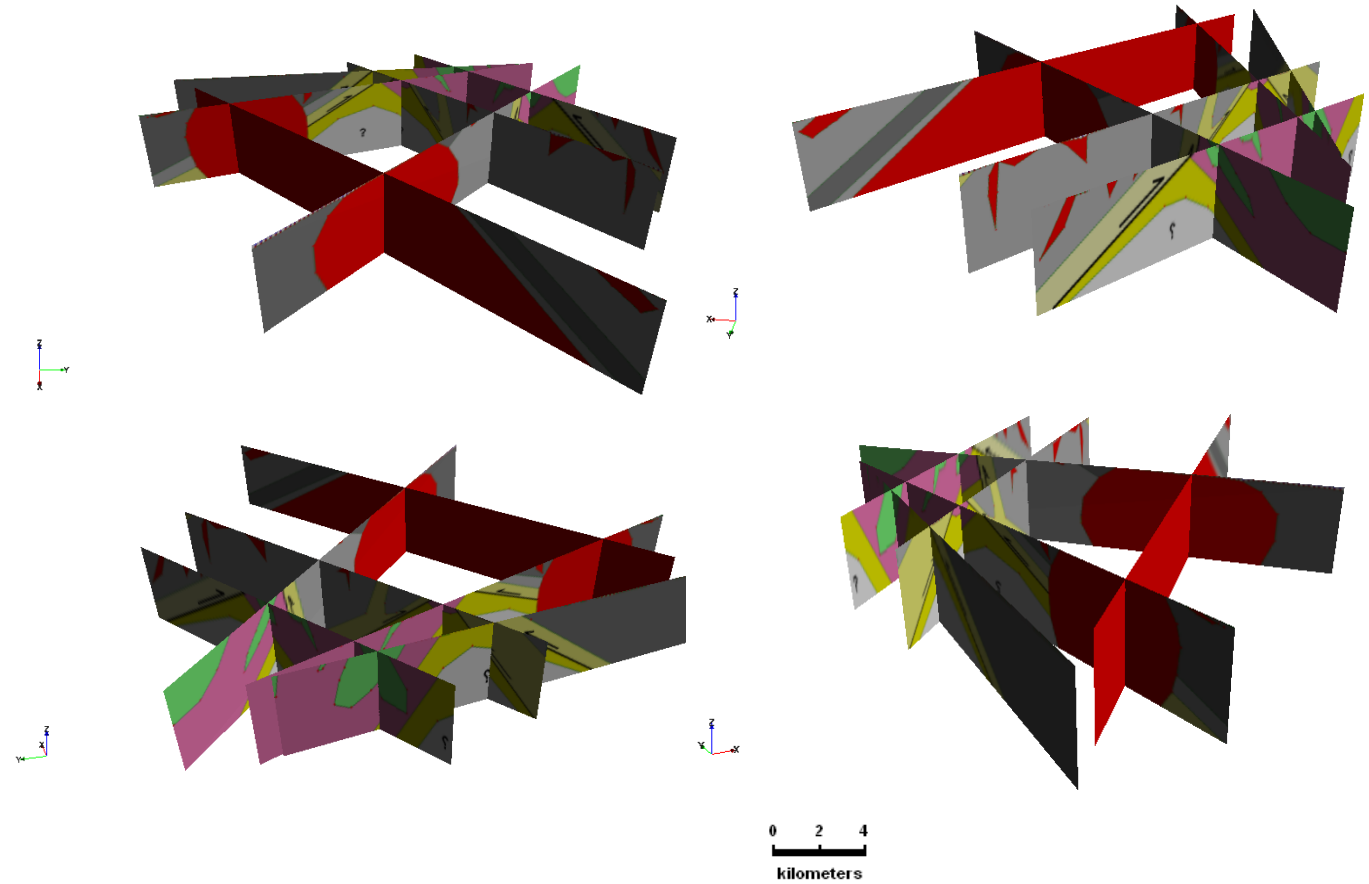
the

1990-2015: McMaster University, the MAGGIC lab

Bathurst…we started producing some very good looking modelled sections

Chester deposit area





1990-2015: McMaster University, the MAGGIC lab

In 2007 we stumbled upon the other black hole: Bathurst, NB (like Sudbury, once you start working there, you never leave!)

2015-"Retired" (yeah right…)

Still publishing like mad. 2018 was 12 articles I think?

Recurring themes: Sudbury, and putting all our data into a geological context.

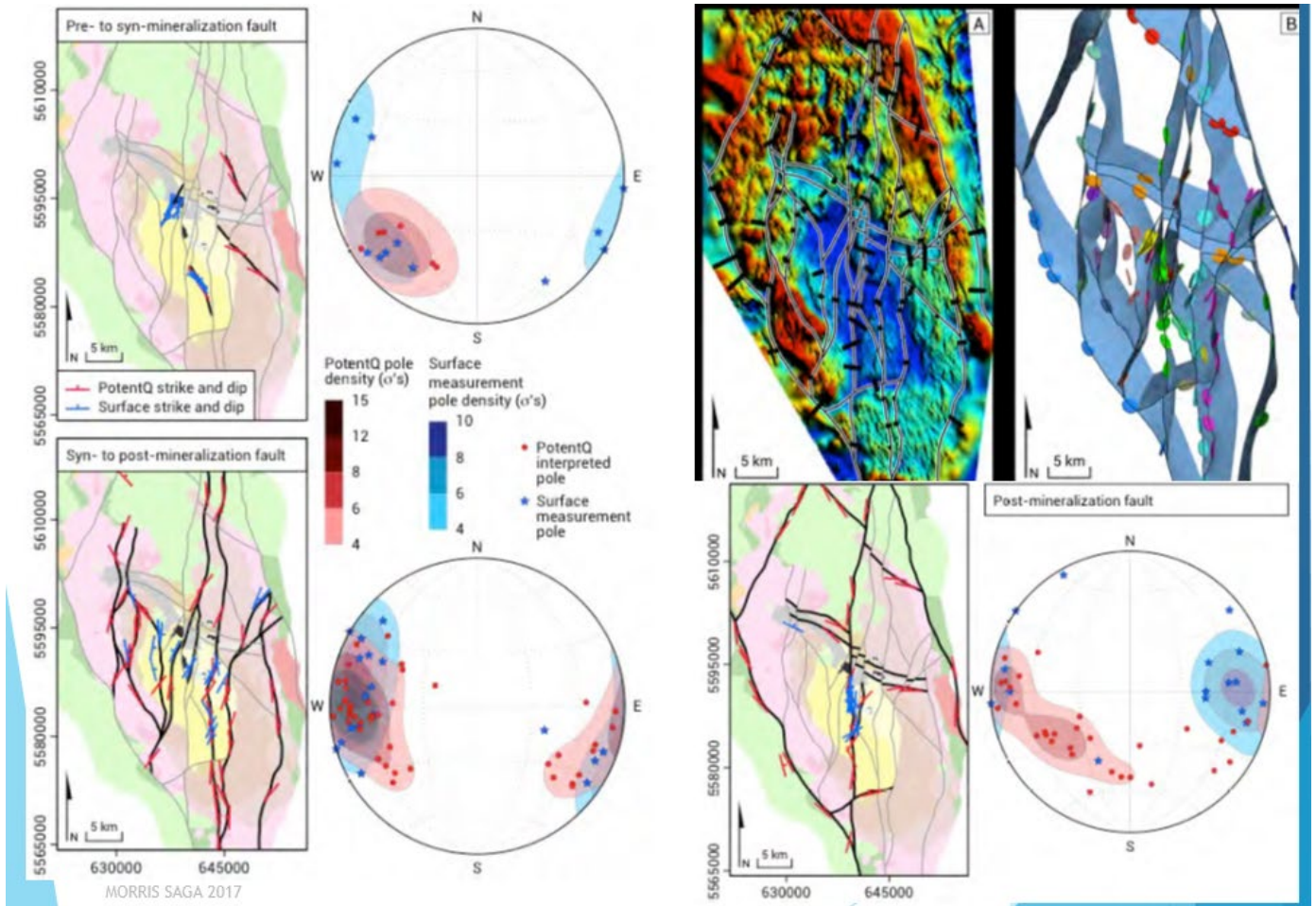
Fracture framework mapping from Magnetics:

A SLIC example

Bill Morris,

McMaster University

Just an example: taking TMI data, topography, a series of edge detection tools, geometry determination via Potent models, and subsequent extrusion in Leapfrog (and of course, stereonet representation)



Reading solutions into Leapfrog it is possible to construct a fracture framework

HVC fracture framework provided by Guilluame Lesage, UBC

2015-”Retired” (yeah right…)

Bill is always ready to bring a stereonet out, crunch everything in Excel, and come with a feasible geological model and interpretation.
If you ask him about Sudbury, he would know the location of every single outcrop, and also who published what and when.
So rather than “Retired”, it is just out of the University admin…

Sudbury and Bathurst, beware WAM and the bats…

“We are not animals!” (@RFG 2018, Vancouver)