



# Newsletter

**December 2007**

**No. 123**

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The NZ Geochemical Group web page is at:  
<http://www.otago.ac.nz/geology/nzgems/html>

*"I see the Geochemical Group as part of the New Zealand scientific community, that is the scientists of the Universities, Government and private enterprise. The prime purpose of this newsletter is to foster communication between members of this community who have an interest in geochemical work in common.*

*Success of the Newsletter depends on all members being contributors. Let us hear, therefore, about your research and your views of the development and aims of the group. There should be plenty of material, as studies in applied, compositional, isotope, mineral phase equilibria, organic and solution geochemistry are in progress and New Zealand is an excellent natural laboratory for such investigations."*

J. Rogers, first Chairman of the New Zealand Geochemical Group, in his Introduction to the first issue of the Newsletter, November 1965.

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incorporating the Mineralogical Society of  
New Zealand



V. M. Goldschmidt  
(1932) p10



The NZ GeMS Newsletter is issued to members of the society to keep them in touch with geochemical and mineralogical research in New Zealand. Material in the newsletter should not be quoted or referred to without the permission of the authors.

Editor: R. B. Glover, 33c Brandon Road, Glen Eden, Waitakere City 0602, New Zealand

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## 2007 - 2009

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NEXT ISSUE: Contributions please to: **Dick Glover**

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## 2007 – 2009 S U B S C R I P T I O N S

***NOW DUE !!***

***NOW DUE !!***

The Society welcomes anyone with an interest in geochemistry and/or mineralogy.

Subscriptions for 2007-2009 are NOW DUE as follows

|                     |                             |
|---------------------|-----------------------------|
| New Zealand members | NZ \$10.00 for 2 years      |
| or                  | NZ \$75.00 life membership  |
| Overseas members    | NZ \$15.00 for 2 years      |
| or                  | NZ \$100.00 life membership |

[Overseas payments should be in NEW ZEALAND DOLLARS by bank cheque, postal note or international money order. All may pay NZ dollars by internet banking into the NZ GeMS account 11-6168-0297175-11 If using the latter option please identify your name or membership number.]

Subscriptions should be sent to **Dr R.B. Glover,**  
**Hon. Treasurer, N Z Geochemical & Mineralogical Society,**  
**33c Brandon Road,**  
**Glen Eden,**  
**Waitakere City 0602,**  
**NEW ZEALAND.**

## Editor's Note:

For many years now we have had the status of a Non Profit Organisation, it is even printed on our bank statements. With this we have not had to file tax returns or pay any tax. The winds of change are sweeping through the beauracracic world and the Charities Commision has been set up to decide who will in future be eligible for tax free status. For trusts and Incorporated Societies the documents can run to 12 or more pages. However, as a small society that is not incorporated we are, according to our secretary able to get away with much less paperwork. Graeme has initiated an email meeting of the NZ GeMS committee to consider our approach. The results of our meeting and the suggested rules of the society follow below. Please read them and if you have any comments, questions or suggestions please email Graeme at [g.lyon@paradise.net.nz](mailto:g.lyon@paradise.net.nz)

**Missing Persons:** I have had a number of Newsletters returned stamped Not known at this address – Return to Sender. If you know the whereabouts of any of the following please ask them to let me know where they are and if they wish to continue to receive the Newsletter. 1) Dr R Parker, Geology Dept Auckland University; 2) Dr Y Mizutani, Toyama University; 3) Lucy Hewlett, Nelson; 4) W J Wopereis; 5) Dr M J F Lawrence.

Please continue to support the Newsletter. We need your contributions to keep the material varied and interesting. We have notes on a number of upcoming conferences. If you wish to use us to advertise your meetings just write the words.

Dick Glover

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## Minutes of a committee meeting of NZGeMS, November 2007, by email.

Present: Graeme Lyon, Dick Glover, Jenny Webster-Brown, Kevin Brown, Dave Craw, Jonathan Kim, Rod Martin, James Pope.

No Comment from: Ed Mroczek, Chris Hendy

Opened: 22 November

Graeme Lyon reported there is a new bureaucracy: the Charities Commission <http://www.charities.govt.nz> which will decide all organisations' ability to get tax-free status. As much of our income is now from interest on the life membership subscriptions, it is suggested that it is necessary that we continue this status. The new rules come into effect 30 June 2008, but are presently taking 3-4 months to process applications. He felt we should start the procedure. He had just registered another organisation so believed he knew the minimum needed.

As a start we need a set of Rules (a constitution) which is against our original principles of informality, but necessary. He suggested that the committee approve a draft set, and Dick puts it in the newsletter for comment, then the committee approve a final version and register, at the latest by end of February. He sent out his draft rules (very short for a set of rules) for comment.

He had gone through the Commission's requirements and minutes of all the old general meetings of NZGG and NZGeMS. Some words are from the resolutions at the BGM 12 May 1993 as required by IRD to first get tax-free status. Rule 5 comes from the BGM of 18 August 1965.

Dave Craw commented that it appeared Graeme had made a problem into a non-problem.

Dick Glover and Jenny Webster queried the suggested end of financial year of 28 Feb. After discussion, 31 March was agreed. Dick asked what the needs for auditing were. Graeme said there seemed to be no specific requirements for auditing so it is left out of the rules.

Kevin Brown was surprised at the short set of rules, but Graeme said incorporated society rules are different, but this set seems to cover what we need, and suggested that as the Commission can provide feedback, and might require changes, we should submit these rules as soon as possible, and see what happens.

James Pope, Rod Martin and Jonathan Kim commented it all looked fine.

The secretary declared the rules accepted by unanimous vote, and proposed to submit them for approval.

Meeting closed 30 November 2007. Graeme Lyon, Secretary

PS. The New Zealand Geochemical and Mineralogical Society was registered with the Charities Commission on 3 December 2007. Approval or comment may take some months. (GLL)

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## **Rules of the New Zealand Geochemical and Mineralogical Society**

1. The name shall be “New Zealand Geochemical and Mineralogical Society”
2. The objects of the Society shall be:
  - (a) To advance education by the promotion of geochemistry and mineralogy and facilitate the interaction between those involved in geological and chemical research and application.
  - (b) To publish a newsletter: The New Zealand Geochemical and Mineralogical Newsletter.
  - (c) To hold a biennial conference and biennial general meeting at which the officers shall be elected.
3. The financial accounting period shall be two yearly, to 31 March, with accounts to be presented at the biennial general meeting. The treasurer and secretary shall arrange 2 or more signatories for the bank accounts.
4. The officers of the Society shall be: President, Secretary, Treasurer, Newsletter Editor and up to 6 other members.
5. Authority to change these rules (except the winding up provision) may be attained by majority committee vote by correspondence rather than at a general meeting. Attempts will be made to continue the informality desired by the Society’s founders.
6. No portions of the funds of the Society shall be paid or transferred directly or indirectly by way of a bonus or dividend to the members. Members may however be reimbursed for approved expenditures.
7. In the event of the Society being wound up, assets shall be transferred to one or more societies with similar or related interests to those of the Society and are charitable under New Zealand law. Winding up shall require a two thirds majority at a general meeting.

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# 20<sup>th</sup> New Zealand Geochemical Group Conference

Incorporating the New Zealand Mineralogical Society 2003

Geology Dept. University of Dunedin, July 2-5, 2007

Abstracts: Part 2                    underlined = speaker

Papers

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## Lake Rotorua

### P and CH<sub>4</sub> in Lake Rotorua

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### The nature, distribution and composition of sediment in Lake Rotorua, New Zealand

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Lake Rotorua has become increasingly eutrophic over the past 2 to 3 decades. The sediments of the lake have been shown to exert an important influence on this eutrophication process. Chemistry of the sediments has been studied to determine the nature, composition and distribution of elements, through a 1.5 year coring programme.

Lake Rotorua has two types of sediments: coarse, dense (density c. 0.5 g/cm<sup>3</sup> dry) sediments comprised of clastic erosion products and coarse rhyolitic airfall components covering approximately 60% of the lake area; and fine, low-density (~0.02 g/cm<sup>3</sup>) diatomaceous ooze that covers the remaining 40% of the lake, accumulated from deposition of biota, predominantly diatom frustules of *Aulacoseira granulata*. The sediment contains a record of volcanic eruptions, with the Tarawera Tephra typically found 0.5 m below the sediment water interface and Kaharoa Tephra typically between 2 to 3 m depth, in water depths of 10-15 m.

Phosphorus concentration in Lake Rotorua sediments decreases with sediment depth. In the centre of the lake phosphorus concentrations in the top 2 cm can exceed 2500 g/tonne and decline to 800 g/tonne at 20 cm depth. Accumulation rate of phosphorus in the sediment based on the nutrient budget is approximately 29.6 t/yr. Iron and manganese concentrations in the sediment depend on the availability of the element and the sedimentation rate of diatom frustules, and are controlled by the redox conditions in the sediment. The average concentration of iron and manganese in the sediment is approximately 8000 g/tonne and between 300 and 400 g/tonne, respectively. Iron accumulates in the sediment at a rate of 385 t/yr and manganese at 17.9 t/yr. Maximum concentrations of arsenic in the sediment are 250 g/tonne but are generally between 50-100 g/tonne, depending on the water depth. Lead concentrations are typically below 15 g/tonne. Sediment concentrations of both arsenic and

lead are highly correlated with iron and manganese concentrations in the sediment and mimic the respective concentration profiles. Arsenic and lead accumulate in the sediment at a rate of 3.71 and 0.49 t/yr, respectively. All elements show a peak in concentration in the tephra layers.

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## Climate changes

### Climate variability during the last glacial period recorded in a speleothem from Westland, New Zealand

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In Westland, New Zealand, glacial geomorphology suggests multiple advances and retreats of ice from the Southern Alps during the last glacial period. The exact timing of ice margin fluctuations are not known due to disparity of published dates on moraines. Although several pollen records from Westland appear in the literature, only one covers the entire glacial period. Therefore there remains a clear need for new, high-resolution records of the last glacial period for this region.

A stalagmite (HW05-3) retrieved from Hollywood Cave in north Westland has the potential to refine the timing of glacier advance and retreat on South Island. The cave's proximity to moraines of the last glacial period means that it is ideally situated to yield an accurate reconstruction of the climate conditions that led to their formation.

To date we have obtained thirteen U-Th dates on the 600 mm tall stalagmite HW05-3. The earliest deposited material is  $73.0 \pm 0.5$  kyr old and a sample 8 mm from the top yielded an age of  $11.8 \pm 0.3$  kyr B.P. The remaining ages suggest that relatively slow growth (1.7-9 mm/kyr) occurred through marine oxygen isotope stages (MIS) 3 and 4 while MIS 2 is characterized by rapid growth (13-29 mm/yr).

In addition to the dates we aim to present preliminary stable isotope ( $\delta^{18}\text{O}$ ,  $\delta^{13}\text{C}$ ) data. Almost 2750 samples have been milled from a continuous track along the growth axis of HW05-3 for stable isotope analysis. Through the last glacial maximum each sample represents 20 years of speleothem growth, significantly higher data resolution than has been achieved for this period by any previous record from Westland.

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## Metal Wastes

### Metalloids in mine wastes, east Otago

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Metalloids boron, arsenic, and antimony occur in mines of east Otago that will be visited by the field trips for this conference, and can contribute to environmental issues for discharge waters. Boron is strongly elevated (up to 450 mg/kg) in S-rich coal at the Wangaloa coal mine. The boron is readily mobilized during weathering of coal fragments in waste rock piles, and dissolved B up to 6 mg/L occurs locally. This boron is attenuated by adsorption to iron

oxyhydroxide (HFO), which is most effective at neutral pH. Since the mine site is moderately acid (pH typically 3-4), adsorption is hindered by acidity. Attenuation is also hindered by competition by sulphate ions for sites on the HFO substrates. However, adsorption is sufficiently effective along the water flow paths to ensure that discharging B concentrations are <1 mg/L.

Arsenic is the most significant metalloid at the Macraes gold mine, with the ore typically containing 1000-2000 mg/kg as arsenopyrite (FeAsS). Arsenopyrite is oxidized in the processing plant to release encapsulated gold, and the As is released into tailings as a poorly crystalline Fe arsenate mineral, somewhat like scorodite (FeAsO<sub>4</sub>·2H<sub>2</sub>O). This mineral dissolves very slowly, releasing 2-5 mg/L dissolved As. Dissolved As is readily attenuated by adsorption to HFO that is part of the processing stream, and is also formed by groundwater interaction with sulphide minerals in waste rocks and tailings along the flow path. High dissolved sulphate (up to 5000 mg/kg) in process waters may limit this As adsorption. Recycling of As-bearing waters to the processing plant ensures that no dissolved As leaves the site.

Antimony is a minor impurity in arsenopyrite, and is mobilized during oxidation of the arsenopyrite. Minor dissolved Sb (0.1 mg/L) is found in some pit waters where rainwater interaction and evaporation have occurred. This Sb is readily adsorbed to HFO and is not discharged from the site.

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## **Field measurement of labile metals in natural acid rock drainage springs, New Zealand**

J. Brown; S. Sander; D. Craw; K. Hunter

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Spring waters were analysed in the field by anodic stripping voltammetry, using equipment which is sufficiently portable to be useful in a remote heavily forested area accessible by foot only. The equipment and techniques are capable of producing analyses on site to the µg/L level for labile metals. Field analysis avoids issues of sample storage and transport protocols that limit confidence in laboratory measurements of labile elements.

Samples were taken as a feedback to immediate analysis resulting in fine grid map of the geological site. Acid rock drainage emanates from a New Zealand historic mine site, with elevated concentrations of metals. However, ground water and surface water discharging naturally from mineralised rocks in the same area also have elevated levels of metals. This study quantifies natural metalliferous discharges from a single site, and compares this to the overall metal flux from the mine area. Acid (pH = c. 3) metalliferous springs emanate from colluvium and bedrock in a young (months-old) landslide.

Labile Cu, Pb, Zn, and Cd are the environmentally most significant metals in the studied area. Labile metal concentrations observed in the natural springs are up to 24 µg/L Cu, up to 50 µg/L Pb, up to 5 µg/L Cd, and up to 9 mg/L Zn. Labile Cu and Zn concentrations are similar to laboratory-determined total concentrations, whereas labile Pb and Cd concentrations are generally distinctly lower than total Pb and Cd concentrations. Four different spring water compositions occur within metres of each other: acid metalliferous water with high Pb, acid metalliferous water with low Pb, high Cu, Pb, Zn acid water, and high pH water with elevated Cu.

High metal concentrations in these waters are readily attenuated by adsorption to iron oxyhydroxides (HFO), especially when rain raises spring water pH at the surface. Cu, P, and Cd are >99% adsorbed, and Zn >95% adsorbed, during this rainfall dilution. Natural spring waters have potential to contribute up to 10% of the total Zn flux from the catchment, but negligible proportions of Cu, Pb, and Cd.

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## Ground water

### Iron-rich groundwater of the Aso caldera, central Kyushu, Japan

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Aso caldera (25km x 18km) is the biggest volcanic calderas in Japan. People who live within the caldera utilize plentiful supplies of groundwater. In the western part of the north caldera basin, Fe-rich groundwaters are common. The highest Fe concentration is 38.9 mg/L, with the pH ranging from 6.2 to 7.4. The water chemistry is classified as Ca-SO<sub>4</sub> type, where SO<sub>4</sub> concentrations correlate with Fe concentrations. To determine the origin of the water, we studied the sulfur isotopic composition of the groundwater in this region. We found <sup>34</sup>S-rich signature of δ<sup>34</sup>S values from +9.7 to +16‰ for the Fe-rich groundwater. These results imply that an acidic hydrothermal system occurs beneath the caldera floor, and that fluid-rock interaction within the aquifer contributes Fe to the local groundwater.

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## Geothermal

### Geothermal Geochemistry Lihir Gold Mine, Papua New Guinea

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The Lihir open pit gold mine in northern Papua New Guinea is unique in that it is located within an active geothermal system and the island is presently self sufficient in electrical power from the 56 MW of geothermal generation. The geological setting within the Luise volcano collapse crater provides a wonderful natural laboratory which is a chemists dream.

The deep geothermal fluids are highly saline with > 100,000 ppm total dissolved solids with abnormally high sulphate levels > 30,000 ppm. The quartz geothermometer temperatures are close to measured temperatures indicating that silica in the fluid is close to equilibrium however the common alkali geothermal geothermometers are not applicable. The deep fluids also appear to be in equilibrium with anhydrite, which is a very common mineral, along with quartz and calcite, in the reservoir rocks. Wells producing from deep liquid feed zones form calcite scales in the well bore which can be inhibited using antiscalent chemicals.

Above the deep liquid reservoir is a 2-phase zone which, through production, has developed into a steam cap. The gas chemistry reflects the boiling of the deep reservoir fluids.

A low permeability zone, known as the anhydrite seal, separates the intermediate steam cap and deep liquid reservoir from the upper reservoir within which the open pit is being developed. The active Lienetz pit is presently at about 130 m below sea level where pre mining temperatures were about 160°C. Dewatering was necessary to allow mining and this was achieved through pumping from wells drilled into the shallow aquifers. The brine pumped is a mixture of geothermal fluids, meteoric water and sea water. A notable increase in sea water component has been observed with time indicating that this is the major recharge fluid to the shallow reservoir.

Mining and processing of low grade ore is planned through to 2040. The current plan is to flood the pits with sea water when mining is completed, however there will be significant inputs into this water body from geothermal brine and gas, as well as fresh water from the crater catchments. Another challenge for the chemists.

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## Trace Metal Sampling Downhole in Geothermal Wells.

Kevin Brown<sup>1</sup> and Stuart Simmons<sup>2</sup>

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<sup>2</sup>*Geology Dept, University of Auckland, Private Bag 92019, Auckland*

Many trace metals in geothermal waters are precipitated on a reduction of temperature and/or a loss of dissolved gases. Consequently, measurement of trace metal concentrations from geothermal fluids collected at the surface often underestimate the concentrations of those trace metals in the geothermal reservoir. We have built a downhole sampling tool to measure the concentrations of trace metals downhole in geothermal wells. The sampler is built entirely from titanium. Being almost totally chemically inert, the sampler can be washed with aqua regia to scavenge any trace metals deposited during the sampling process.

Analysis of downhole samples at many geothermal fields in the TVZ has indicated that while gold is undersaturated in most geothermal reservoirs, silver sometimes reaches saturation. Analysis of gold concentrations from downhole samples from the Lihir Gold Mine showed that all of the gold present in the mine could have been deposited in 55,000 years.

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## Believe it or Not

Richard B Glover

[ggg@pl.net](mailto:ggg@pl.net)

Glover Geothermal Geochemistry, 33c Brandon Road, Glen Eden, Waitakere City, 0602

A look at some unusual geothermal incidents at Wairakei.

\* The role of Karapiti “blowhole” in saving the life of Gilbert Mair, an early New Zealand surveyor.

\* A death in the Karapiti area. \* When collecting Wairakei ignimbrite for Ellis and Mahon’s classic high temperature rock / water reactions was a subversive activity. \* How, or, how not, to increase well output, WK66. \* Let me out (1) The Birth and Death of the “Rogue Bore”, WK204.

\* Let me out (2) The bore that s.t.r.e.t.c.h.e.d. WK212. \* The pipeline that went for a sudden walk – “H” Line. \* MOW give DSIR a lesson in PR. \* The great escape.

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*On the 60<sup>th</sup> anniversary of V M Goldschmidt's death, Geoff Glasby\* explores the life and times of one of geochemistry's pioneers...*

\*Dept. of Geochemistry, GZG, Goldschmidtstr. 1, University of Göttingen, Germany:

[g.p.glasby@talk21.com](mailto:g.p.glasby@talk21.com) Geoff was with Oceanographic Institute, before moving off-shore, and has published at least two articles in the Newsletter. "Submarine Geothermal Activity in the Bay of Plenty" in November 1973 and "Manganknollen aus dem Zentralen Pazifik" (Manganese nodules of the Central Pacific?) in March 1980 and has been a member of NZGG for about 35 years. This article is part of paper called "Goldschmidt in Britain" in *Geoscientist* Vol 17 No.3 pp22-27. [I thank Geoff for providing a copy of the original and accept the responsibility of any errors in reproducing it here. If anyone would like a .pdf copy of the paper in *Geoscientist* or a longer (18 page) paper by Geoff in *The Geochemical News* please contact the writer or myself - Editor]

Victor Moritz Goldschmidt is one of the greats of geochemistry, whose pioneering work in the early decades of the 20th Century established the new discipline of geochemistry<sup>1</sup>. His successful interwar research in Oslo and Göttingen and the reasons for his departure from Göttingen in 1935 as a result of the rise of the Nazi Party are well known. Less well known are his contacts with scientific colleagues in Britain, the circumstances of his move to Britain in 1943 and the seminal role of British scientists in ensuring Goldschmidt's future reputation after the war.

In 1935, Goldschmidt left Göttingen, despite support from his fellow academics, in protest at the increasingly harsh restrictions placed on Jews as the power of the Nazi party increased. Returning to Oslo without prospects, he fell back on his industrial work until his appointment to an academic post in 1936, whereupon, for the third time, he established a laboratory and expanded his work on element abundances to include the solar system.

However, with the German occupation of Norway from 1942, Goldschmidt's life became increasingly hard. He made no secret of his Jewish heritage and suffered for it. His home and money were confiscated, as were his library, papers and laboratory equipment. He was arrested, threatened with deportation to Auschwitz and spent time in Berg concentration camp. He was released following the intervention of senior colleagues from the university on the basis of the value of his work to the state. Under the threat of deportation, he escaped to Sweden in December 1942.

On March 3 1943, Goldschmidt was flown to Britain by the Secret Intelligence Service where he passed on information about technical developments in occupied Norway. He then stayed on in London, amid uncertainty about his role; the Norwegian government in exile supported him, but did not want him to stay in London at their expense. In August 1943, it was finally agreed that he would work for the Agricultural Research Council and he moved to the Macaulay Institute for Soil Research in Aberdeen.



V.M. Goldschmidt on a field trip in the Stavanger area of southern Norway in 1922 where he met C.E. Tilley for the first time.

During that summer, Goldschmidt was heavily involved in discussions with the Norwegian and British authorities on German exploitation of raw materials and production of heavy water in Norway among other things<sup>1</sup>. He also attended conferences in Cambridge, Manchester, Sheffield, Edinburgh and Aberdeen and gave a lecture to the British Coal Utilization Research Association on the occurrence of rare elements in coal ashes.

This busy five months in London was by no means his first contact with UK researchers. Goldschmidt had a lifelong connection with Leonard Hawkes, later President of the Geological Society of London, who carried out the studies for his M.Sc. in Oslo on the geology of Iceland in 1914-1915 and he knew C E Tilley from the field meeting in Stavanger in 1922.

He also visited W H Bragg in 1921 to ask for his help in determining the structure of calcium carbide in order to get exemption from tariffs imposed on imports of organic chemicals to Britain.

In 1928, Goldschmidt met J D Bernal for the first time at Bad Ems where they talked about crystal chemistry nonstop for 12 hours. He was also invited to give lectures at the Faraday Society and the Royal Institution by Sir William Bragg in 1929 when he probably met J D Bernal, W L Bragg and Kathleen Lonsdale. Goldschmidt was elected a Foreign Fellow of the Geological Society of London in 1931 and an Honorary Member of the Mineralogical Society in 1933. In March 1937, Goldschmidt gave the seventh Hugo Müller lecture of the Chemical Society. These lectures were published, giving excellent accounts of his work up to this time. However, they were not published in mainstream geological journals and would not have been well known within the British geological community. In September 1939, L R Wager, then at the University of Reading, sought Goldschmidt's advice on the use of biotite as a substitute for potash fertilisers imported from Germany seven days after the outbreak of war. Tilley's masterly overview of Goldschmidt's scientific contributions after his death suggests that his work was very influential in British geology in the interwar years, at least in some quarters. In going to the Macaulay Institute in 1943, Goldschmidt had an enormous stroke of luck because he came under the influence of the Director of the Institute, Dr W G (later Sir William) Ogg, who was to become his patron for the rest of his stay in Britain. Despite illness when he arrived in Aberdeen, Goldschmidt was soon at work again, publishing on crystal chemistry and geochemistry<sup>7</sup>, and on the geochemical background of minor-element distribution. Both papers were essentially summaries of his earlier work in German but, again, they brought his work to a wider audience.

At the urging of Ogg, Goldschmidt spent much of his time at the Macaulay working on his magnum opus on geochemistry<sup>1</sup> and took great interest in soil research through his contacts with Ogg, Alex Muir and others. In 1943, Ogg became director of the prestigious Rothamsted Experimental Station in Harpenden after the retirement of Sir John Russell, but remained an honorary director at the Macaulay Institute until 1945. Goldschmidt stayed at the Macaulay Institute for almost a year after Ogg left. At that time, British agriculture was still struggling to come to terms with the upheavals of the war years and the attendant food shortages<sup>10</sup>. In September 1943, Goldschmidt was involved in setting up a committee to discuss research into clay minerals and soil formation which might in turn improve Britain's self-sufficiency in food. Goldschmidt also prepared a memorandum entitled *Development of Geochemical Research in Great Britain and in the British Commonwealth* dated January 24, 1944 in which he gave his opinions on the future development of geochemistry in Britain, with particular regard to problems of industrial and agricultural importance. He proposed the setting up of an institute to undertake systematic studies of geochemistry that could lead to increased use of the mineral resources of the British Empire, and advise on the most profitable use of soil. In this regard, he considered the future evolution of geochemistry to be of the utmost importance from both a scientific and an economic (agriculture, mining and industry) standpoint.

While at the Macaulay Institute, Goldschmidt was elected a Foreign Member of the Royal Society (one of 50) for his work on the metamorphic petrology of Norway, the crystal

structure of ionic compounds and the terrestrial distribution of the elements. In January 1944, he was awarded the Wollaston Medal, the highest award of the Geological Society of London, and in February 1944, he was awarded an honorary Doctor of Laws (LLD) by the University of Aberdeen. In May 1945, Goldschmidt was also elected an Honorary Member of the Chemical Society. These awards show the high esteem in which Goldschmidt was held in Britain at that time. Goldschmidt moved from Aberdeen to Harpenden to continue to work with Ogg in 1944, but heart trouble before and after the move severely restricted his activities. He continued to work, writing papers for publication and producing a manuscript (published posthumously) on the geochemical aspects of the origin of complex organic molecules on Earth as precursors to organic life.

Here Goldschmidt became the first (with J D Bernal) to recognise the role of clay minerals in transforming organic molecules into the precursors of organic life - a topic that remains an active field of research to this day. Goldschmidt made a good impression in Britain. At Rothamsted, he was liked by everybody and was affectionately called 'Goldie'. In return, he deeply appreciated the help extended to him at Macaulay and Rothamsted. However, he was determined to return to Oslo - a decision not universally welcomed in Norway. In spite of this, and delayed again by illness, Goldschmidt finally returned there on 26 June 1946.

His homecoming brought him happiness, restored his house (requisitioned during the occupation) to him and work as Director of the Geological Museum and the Raw Materials Research Laboratory. Despite continuing illness, he was publishing again and intending to attend the International Chemical Conference in London in July 1947. But in late 1946 he had had treatment for malignant melanoma and, following a later operation for cancer, he died at home on 20 March 1947.

After Goldschmidt's death, much effort was put into producing his *Geochemistry*, particularly by Alex Muir who acted as editor for this volume. The "Goldschmidt rules" for the distribution of trace elements were also extensively examined and found wanting in many respects; yet, as Goldschmidt himself understood, they functioned as an approximation based on many examples. These and much else in Goldschmidt's great body of research laid the foundations for modern geochemistry as a science based on fundamental physics and chemistry.

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## **MEDIA RELEASE FROM GNS SCIENCE**

22 NOVEMBER 2007

**METHANE-EATING BUG HOLDS PROMISE FOR CUTTING GREENHOUSE GAS**

A methane-consuming microorganism that lives in geothermal areas in Rotorua has attracted international attention for its ability to live in extremely acidic conditions. Discovered by researchers at GNS Science, the bacterium could one day be used to reduce methane gas emissions from landfills. It could also help to cut methane emissions from geothermal power stations.

The science journal *Nature* has just published a paper on the microorganism, which was discovered in soil at Tikitere geothermal field, also known as Hell's Gate, near Rotorua. Climate researchers are expected to follow the discovery closely as the bacterium offers the potential to reduce the amount of methane entering the atmosphere. Methane is a far more potent greenhouse gas than carbon dioxide.

The hardy bacterium is part of a group known as methanotrophs, but this one is able to live in hotter and much more acidic conditions than its relatives. Methanotrophs use methane as their only source of energy. They live mostly in soils and are especially common in environments where methane is produced.

Microbiologist at GNS Science, Matthew Stott, said it was a particularly exciting discovery as it had international significance. “We knew methane was being produced geothermally at Hell’s Gate and we were puzzled as to why it wasn’t reaching the surface,” Dr Stott said. “What we have found is an extremely tough methane-consuming organism that is new to science. It grows happily under extremely acidic conditions in the lab.” Globally, acidic environments such as marshes and peat bogs generate significant quantities of methane. Scientists have always suspected that a proportion of this methane was being consumed by bacteria living in these environments. “Our discovery has demonstrated that methane-consuming organisms do live in highly acidic environments. Without them, the amount of methane entering the atmosphere would be much greater. “Ultimately, it may be possible to implant this organism, or a similar one, in landfills and cut methane emissions into the atmosphere.”

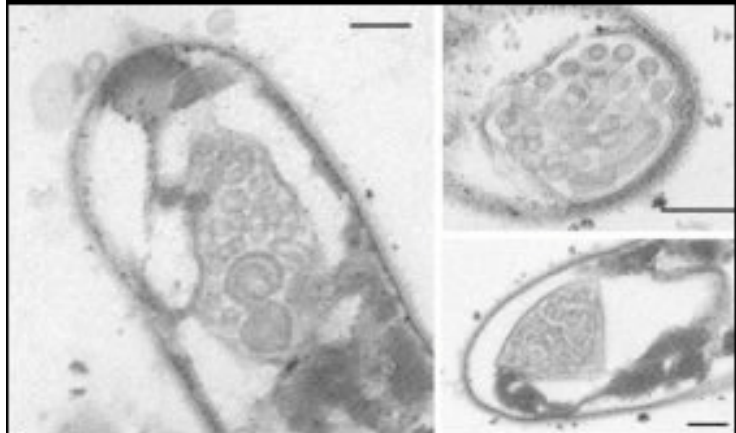
Fellow microbiologist at GNS Science, Peter Dunfield, who isolated the bacterium, has tentatively named it *Methylokorus infernorum*, which is a latinised description of its methane food source, the ‘hellish’ location of its discovery, and also a description of a structure within its cell that resembles a Koru.

GNS Science worked with colleagues at the University of Hawaii to sequence the genome of the bacterium. They found its genetic makeup was different to all known methanotrophic organisms.

The discovery stems from a collaboration between GNS Science and the owner and operator of Hell’s Gate, Tikitere Trust. The agreement between the two organisations includes the sharing of any benefits that might accrue from scientific discoveries. Spokesman for Tikitere Trust, Jim Gray, said the discovery had the potential to put New Zealand and Tikitere Trust at the leading edge of extremophile science internationally. “The Trust sees this is an exciting development that has both commercial and scientific implications for New Zealand.”



Microbiologist Matthew Stott, of GNS Science, has searched far and wide for extremophile organisms that will be useful to humans. This includes using a submersible to gather samples from submarine volcanoes in the Kermadec Arc, northeast of New Zealand.



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## Upcoming Events

NZ Trace Elements Group Conference (Hamilton) 13-15 February, 2008.

[www.tracenz.org](http://www.tracenz.org)

Goldschmidt2008 (Vancouver, Canada) July 13-18. [www.goldschmidt2008.org](http://www.goldschmidt2008.org)

## The Origin of Hot Springs

By Rabelais (contributed by S H Wilson to NZGG Newsletter No 57 March 1980)

....Shortly after, Pantagruel was taken ill. He suffered so severely from stomach trouble that he could neither eat nor drink. As afflictions never come singly, something else rose to torment him more cruelly than you can possibly imagine. What happened was this: a stroke of misfortune caused the pale yellow fluid secreted by his kidneys, stored in his bladder and discharged by his urethra, to burn like the geysers of hell.

Fortunately, his physician treated him with great skill, and thanks to various lenitives and diuretics, he voided his ailment and urine simultaneously.

The latter was so hot that it has not cooled off yet. According to the course it took, you can still find it in France in so-called watering places or thermal springs. Such spas are Luchon in the Pyrenees and Cauterets, near by.... Neris in Bourbonnais.... Bourbonne- Lancy in Burgundy... Jets of Pantagruel's penial flood landed in Italy in Appona, St Peter in Padua, St Helena, Casanova, St Bartolemo, and in the country of Bologna, at Porrette, and in a thousand other places.

That a horde of foolish scientists and physicians waste their time arguing about the origin of these boiling springs is, to me, an amazing phenomenon. Some vow it is borax, others alum. Still others champion the cause of saltpetre. Tommyrot, all of it. They would do far better to rub their scuts with thistles than consume their energy discussing a matter they know nothing about. The answer is clear. The only possible conclusion is that these watering places are hot because they came from water made by Pantagruel when a slight misadventure caused that water to flow hot.

Gargantua and Pantagruel Book 2, Chapter XXXIII. Written in 1532.

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*"Every attempt to employ mathematical methods in the study of chemical questions must be considered profoundly irrational and contrary to the spirit of chemistry . . . , and would occasion a rapid and widespread degeneration of that science"*

A. Compte in "Philosophie Positive " 1830.

## Quotes from papers presented at earlier conferences:

"Some of my best friends are geologists, but I wouldn't like one to marry my grandmother".  
Russell James in 'Estimated drilling depth to permeable hot water geothermal reservoir' 1979.

" The best technique for geothermal exploration is walking with bare feet – the natives knew this long ago. " again Russell James *ibid.* *idem*

" I report data measured by my colleagues on bludged samples using borrowed equipment by a technique developed by other people." W. C. Tennant in 'Fe<sup>3+</sup> and Mn<sup>2+</sup> sites in Tremolite by ESR and Ultrasonically Modulated Electron Resonance' 1979