



# Newsletter

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The NZ Geochemical Group web page (thanks to Dave Craw and Otago University) is at:

<http://www.otago.ac.nz/geology/nzgg/nzgg.html>

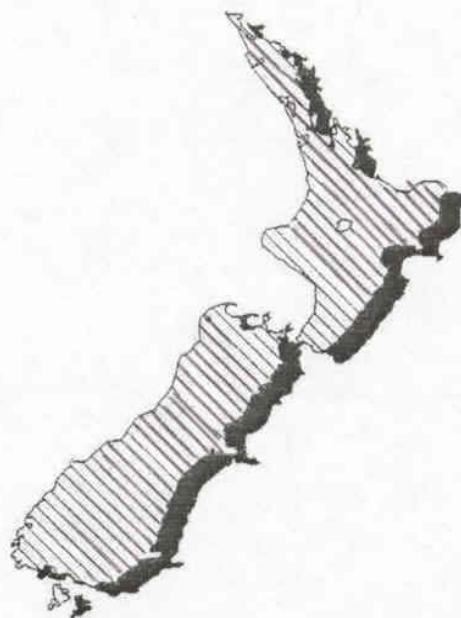
*"I see the Geochemical Group as part of the New Zealand scientific community, that is the scientists of the Universities, Government and private enterprise. The prime purpose of this newsletter is to foster communication between members of this community who have an interest in geochemical work in common.*

*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.

***Incorporating  
The  
Mineralogical  
Society of  
New Zealand***



N.Z. Geochemical Group Newsletter is issued to members of the Group to keep them in touch with New Zealand geochemistry. Material in the Newsletter should not be referred to in scientific papers without the permission of the author.

c/o R. B. Glover, 33C Brandon Road, Glen Eden, Auckland, New Zealand

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Editor-in-Chief and Distribution Organiser: Dick Glover. Contact above as for Treasurer

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

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## 2005 – 2007 S U B S C R I P T I O N S

***NOW DUE !!***

***NOW DUE !!***

The Group welcomes anyone with an interest in geochemistry.

Subscriptions for 2005-2007 are NOW DUE as follows

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| Overseas libraries    | NZ \$14.00 for 2 years     |

[Overseas payments should be in NEW ZEALAND DOLLARS by bank cheque, postal note or international money order.]

Subscriptions should be sent to **Dr R.B. Glover,**  
**Hon. Treasurer, N Z Geochemical Group,**  
**33c Brandon Road,**  
**Glen Eden,**  
**Auckland, NEW ZEALAND.**

## Editor's Note:

My **first issue** as editor.

I take up the job with some trepidation and ask for your support, especially in providing material for the Newsletter. I have compiled a table of Chairmen, Presidents (why this change of description for the same office? Was it as the latter was sexually neutral?), Editors, Secretaries and Treasurers. As you will note we have been well served by many people, with world-wide reputations in their academic fields. I see that Stuart Wilson edited 39 Newsletters *after* asking to resign. I also note the time (#71 to #90) when a different group took responsibility for each edition during the two-year cycle. As I am at best part-time employed, a similar support system would assist me and ensure that a wide range of topics are covered. I'll also feature a "Letters to the Editor" section where comments or queries can be aired. When I was researching the past officers I wondered where they are now and what their interests are. I'd like to include a column of views from past Chairmen / Presidents initially. This could be as wide in scope as the person writing wishes. Possibilities include, reflections on past work, reflections on the NZGG, line of work / interests pursued now, recent (or older) articles you have found stimulating.

Dick Glover

### NZGG Office Bearers

| Date   | Newsletter | Chairman           | Editor  | Secretary             | Treasurer       |
|--------|------------|--------------------|---|-----------------------|-----------------|
| Nov-65 | 1          | John Rogers        | Stuart Wilson (SHW)   | Stuart Wilson         | Stuart Wilson   |
| Jul-67 | 6          | "                  | "   | Jim Ellis             | Jim Ellis       |
| Mar-69 | 12         | Robert Brooks      | "   | "                     | "               |
| May-70 | 17         | Jim Ellis          | SHW asks to resign  | Reiner Goguel         | Reiner Goguel   |
| Jul-71 | 22         | Tony Wodzicki      | Stuart Wilson   | "                     | "               |
| Jul-73 | 30         | Mel Carr           | "   | Dick Henley           | Dick Henley     |
| Jun-75 | 38A        | Reiner Goguel      | "   | Bob Heming            | Bob Heming      |
| Nov-75 | 40         | "                  | John Ritchie  | "                     | "               |
| Jun-77 | 46         | Tony Mahon         | SH Wilson (acting)  | Bruce Finlayson       | Bruce Finlayson |
| Dec-77 | 48         | "                  | Werner Giggerbach (WFG)<br>Watson Kitt (assistant)                      | "                     | "               |
| Jun-79 | 54         | Terry Seward       | "   | Steve Weaver          | Steve Weaver    |
|        |            | <b>President</b>   |   |                       |                 |
| Dec-79 | 56         | Terry Seward       | WFG (executive)<br>Doug Sheppard (actual)<br>Watson Kitt (distribution) | "                     | "               |
| Sep-81 | 63         | Jim Johnston       | Doug Sheppard<br>Watson Kitt (distribution)                             | Jock Churchman        | Jock Churchman  |
| Jul-83 | 67         | Peter Hodder       | Doug Sheppard<br>Werner Giggerbach<br>Graeme Lyon                       | Kevin Brown           | Dick Glover     |
| Aug-85 | 72         | Doug Sheppard      | Graeme Lyon   | Brian Robinson        | "               |
| Sep-87 | 79         | Kevin Brown        | "   | Bruce Christenson     | "               |
| Jul-90 | 86         | Mike Timperley     | "   | Keith Nicholson       | "               |
| Oct-91 | 89         | Chris Hendy        | "   | Bruce Finlayson       | "               |
| Jul-93 | 92         | Mel Carr           | "   | "                     | "               |
| Nov-95 | 97         | To Be Announced    | "   | Ian Graham            | "               |
| Apr-96 | 98         | Jo Deely           | "   | "                     | "               |
| Oct-97 | 101        | David Grant-Taylor | "   | Agnes Reyes           | "               |
| Nov-99 | 105        | Jenny Webster      | "   | Catherine Chagué-Goff | "               |
| May-01 | 109        | Ed Mroczek         | "   | "                     | "               |
| Aug-03 | 113        | Chris Hendy        | "   | "                     | "               |
| Sep-05 | 118        | Jonathon Kim       | "   | Graeme Lyon           | "               |
|        | 119        | "                  | Dick Glover   | "                     | "               |

NB From #71 to #90 the Editor was assisted by a committee so that each edition was compiled by a different group.

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*New Web Page*

Thanks to Dave Craw and Stephen Read of Otago University and Elizabeth McKenzie, a new web site has been set up and users of the previous one are now redirected automatically. The site is: <http://www.otago.ac.nz/geology/nzgg/nzgg.html>

**Letters to the Editor**

Good morning Dick, at least here, from Arizona,

Even though email reception here is rather slow, I've decided to try getting the New Zealand Geochemical Group Newsletter that way. Large files with lots of pictures can be quite time-consuming -- up to two hours -- and I may wish to change back to hard copy.

I noted with particular interest in the last issue, No. 118, the abstract by Alison Leslie on arsenic. Several years ago I was involved as a consultant on the Tacoma, Washington, Superfund Site, which was badly contaminated with arsenic from the smelter. There a major issue, perhaps the greatest, was the release of arsenic from contaminated soils via arsines, of which there are many varieties, not just AsH<sub>3</sub>. The worst ones are organic, which contain methyl, ethyl and other groups in place of hydrogen. Most are volatile, and being heavy, tend to stay close to the ground. This was particularly a problem for children playing on lawns. Apparently Alison has not considered these as a possible release route of arsenic from the Waikato River. Do you know whether she investigated this possibility?

Best regards,

Paul L. Cloke

[Editor's note: This has been passed on the Alison and is printed here with Paul's permission]

**For Managers...**

A crow was sitting on a tree, doing nothing all day. A small rabbit saw the crow, and asked him, "Can I also sit like you and do nothing all day long?"

The crow answered: "Sure, why not." So, the rabbit sat on the ground below the crow, and rested.

All of a sudden, a fox appeared, jumped on the rabbit and ate it.

Management Lesson:

To be sitting and doing nothing, you must be sitting very, very high up

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

Incorporating the New Zealand Mineralogical Society 2003

Orakei Korako Resort, June 27-30, 2005

Abstracts: Part 2                    underlined = speaker  
Oral Presentations

## KEYNOTE ADDRESS

### *Environmental Geochemistry*

#### **Advances in Analytical Chemistry and Environmental Awareness - A coming of age for environmental geochemistry**

Chris Hendy

*Chemistry Department, University of Waikato*

In the 40 years I have been a geochemist I have seen and taken part in an enormous leap in abilities to analyze the chemical, physical and isotopic composition of environmental solids, solutions and gases. The detection limits have been progressively reduced by six or more orders of magnitude with corresponding increases in both precision and range of species analyzable. This has initiated a revolution in our understanding of environmental geochemistry. The role of iron and manganese as mobilisable binders, the behaviour of phosphate and arsenic species, the environmental chemistry of trace metals such as copper, zinc, cadmium, mercury and lead have all become accessible with our ability to determine their abundances to sub ppb levels. In the isotopic field new fractionation processes such as extreme enrichment during freezing and non thermodynamic 0-17 anomalies have continued to extend the usefulness of traditional isotope studies, while new mass spectrometric techniques have extended the range into heavier non volatile elements. The unforeseen consequence of this coming of age has been the splintering of the geochemical group, once largely centred on geothermal geochemistry into many specialist groupings, each with their own specialist meetings.

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### *Environmental Geochemistry*

#### **Dissolved Mercury in South Island New Zealand Lakes**

Jonathan Kim

*Department of Chemistry, University of Otago, P. O. Box 56, Dunedin*

Dissolved mercury (Hg) was determined in several lakes of the South Island, New Zealand. Surface water samples were collected from Lakes Manapouri, Te Anau, Hawea, Wanaka, Wakatipu and Hayes. In addition, two depth profiles for dissolved Hg were obtained during the Austral summer (February) and winter (June) for Lakes Hauroko and Hayes during 2004. Dissolved Hg concentrations ranged from 1 to 12 picomoles per litre, which are typical for values observed in other pristine lakes in North America and Europe. In general, higher dissolved Hg values observed during February than during June for both lakes. A sub-surface

dissolved Hg maximum was observed in both lakes during the summer, and the dissolved Hg concentration also increased in the anoxic bottom water in Lake Hayes at this time.

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## *Minerals*

### **Secondary Minerals of Ruatapu and Rahu Rahu Caves, Orakei Korako**

Rod Martin  
[pincha@ihug.co.nz](mailto:pincha@ihug.co.nz)

Ruatapu and Rahu Rahu caves have developed in rhyolitic tuffs of the active Orakei Korako geothermal field.

Within the caves the secondary minerals can be divided into three distinct suites resulting from the action of acid sulphate fluids on the rhyolitic host rocks.

1. Kaolinite ± silica ± alunite ± alunogen
2. Jarosite ± potash alum ± ferrioxyhydroxides
3. Efflorescences

Of particular interest are the secondary silica pseudomorphs found attached to the roof of Rahu Rahu Cave and comparisons with similar formations found in volcanic caves in Sicily, Iceland and Australia.

#### **Further reading**

Cody, A.D. (1978) Ruatapu Cave, Orakei Korako. *New Zealand Speleological Bulletin*, **6** 184-187.

Forti, P., (2005) Genetic processes of cave minerals in volcanic Environments: An overview. *Journal of Cave and Karst studies*, **67(1)**, 3-13.

Rodgers, K.R., Hamlin, K.A., Browne, P.R.L., Campbell, K.A. and Martin, R. (2000) The steam condensate alteration mineralogy of Ruatapu Cave, Orakei Korako geothermal field, Taupo Volcanic Zone, *N.Z. Mineralogical Magazine*, **64(1)**, 125-142.

Webb, J.A. (1985) Acicular opaline speleothems from Mt. Hamilton Lava Cave, Western Victoria. *The Australian Mineralogist*, **49**, 291

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## *Environmental Geochemistry*

### **Dissolution and attenuation of arsenic at an historic quartz vein-hosted gold mine, Waiuta, New Zealand**

Laura Haffert and Dave Craw  
*Geology Department, University of Otago, PO Box 56, Dunedin, New Zealand*

Historic mining and extraction processes used at mine sites in the Reefton Gold field have left a legacy of ongoing As contamination. The Prohibition Mine site at Waiuta, in the southern sector of the Reefton gold field, is a popular public viewpoint administered by DoC. Mine

wastes contain secondary arsenic minerals including scorodite ( $\text{As}^{\text{V}}$ ) and more soluble arsenic trioxides ( $\text{As}^{\text{III}}$ ). The presence of anthropogenic arsenic trioxides indicates that ore processing procedures have an important control on the available As source. Water in a wetland pond at this site contains As levels up to  $77 \text{ g As / m}^3$ , nearly 10 000 times higher than drinking water limits. This site represents a major point source for As in the surrounding environment. Arsenic attenuation in the aqueous system is strongly controlled by the presence of suitable sorption sites, commonly iron oxyhydroxide (HFO). The Waiuta area shows very little evidence of HFO production and As levels above drinking water level are persistent downstream of the river draining the mine site. The spatial scale of As transport at this site is greater than in the northern area of the Reefton Gold field where HFO is abundant and causes strong attenuation by adsorption.

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## *Environmental Geochemistry*

### **Impact on an effluent plume from cessation of effluent discharge.**

Kathleen Dabell<sup>1</sup> John Hadfield<sup>2</sup> Chris Hendy<sup>1</sup> Nick Kim<sup>2</sup>

<sup>1</sup> Chemistry Department, University of Waikato. Private Bag 3105, Hamilton, New Zealand

<sup>2</sup> Environment Waikato Box 4010, Hamilton East, Hamilton, New Zealand

Due to problems with the soakage field at the Kinloch water treatment plant a new field was used in conjunction with a trialing of new treatment technologies. This has resulted in a change of the effluent discharge location

Monitoring of the old soakage field was carried out to observe what occurred within an established plume when discharge ceased.

Upon cessation of discharge to the lower soakage field a decrease was seen in the water table level, and the concentrations of phosphorous, nitrate, sodium, potassium, magnesium, and chloride. These concentrations then rose again sharply before beginning a more gradual decrease that could be attributed to the stop of discharge. What has caused this sudden decrease in concentration? Is it due to an input of rain water, does the effluent form a layer that is sampled in frequently? Or is there something else that is impacting the surrounding groundwater.

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## *Antarctica*

### **Former Depositional Environments and Lake-Level Changes in Fryxell Basin, Antarctica**

Thomas E. Whittaker

*Chemistry Department, University of Waikato. Private Bag 3105, Hamilton, New Zealand*

Isotope records ( $\delta^{18}\text{O}$ ,  $\delta^{13}\text{C}$ ,  $^{14}\text{C}$ ), sedimentology, and diatom assemblages from eighteen Lake Fryxell ( $77^{\circ}37'\text{S}$ ,  $163^{\circ}06'\text{E}$ ) sediment cores are used to infer former depositional environments within the basin over the period  $> 30 \text{ kyr B.P.}$  to the present. Changes in

sediment type most likely reflect variations in meltwater production related to regional climate and ice-sheet dynamics. The chronology comes primarily from U/Th dates. Several  $^{14}\text{C}$  dates were also obtained, although they contain an unknown and variable magnitude reservoir effect rendering them more useful as lake level indicators than as dates. I recognize eight sedimentary units (designated 1-8) within the upper eight meters of Lake Fryxell sediments.

The lower 520 cm of the core (Units 4-8) record a shallow-lake environment and include sand and evaporite layers. Superceding these shallow lake sediments is a blue-gray silt (Unit 3) indicative of a deep-lake environment. Unit 3 silt is contemporaneous with Glacial Lake Washburn highstands, ~11-22 kcal yr B.P., and is marked by elevated  $\delta^{18}\text{O}$  (-17 to -21 ‰) and marine diatom fragment abundance, indicating that the lake at this time was fed by meltwater from the Ross Sea Ice Sheet. Unit 3<sup>1</sup> sediments, and nine sand layers in Unit 3, represent millennial-scale lake-level lowstands during the Glacial Lake Washburn phase. At  $11,100 \pm 1200$  yr B.P. Lake Fryxell reached a lowstand at about 15 m elevation, and deposited a thick (21 cm) aragonite layer across the basin (Unit 2a). Radiocarbon age data indicates that the lake environment was not stable during the deposition of the aragonite despite its lithological uniformity. Holocene-age sediments in Lake Fryxell (Units 1a-1c<sup>1</sup>) are composed of aeolian sand, with algal and carbonate laminae. There is evidence of only minor lake-level changes ( $\pm 5$  m) in the Holocene.

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## ***Geothermal***

### **Life on the Edge: Microbes, Metals and Minerals in New Zealand's Geothermal Systems**

Bruce W. Mountain

*Extremophile Research Group,*

*Institute of Geological and Nuclear Sciences, Wairakei Research Centre, Taupo, New Zealand*

The New Zealand continent, of which about two thirds is submerged, straddles the plate boundary between the Pacific and Australian tectonic plates. Subduction of the Pacific plate has led to the development of the Tonga-Kermadec intra-oceanic arc system that extends down into New Zealand's North Island ending at Mt. Ruapehu. From Tonga to Mt. Ruapehu, numerous undersea and terrestrial geothermal systems have developed containing abundant evidence of extremophilic micro-organisms. They have been identified in deep-sea hydrothermal vents, volcanic crater lakes, acidic boiling mud pools, hot springs, geysers, steaming ground and even in the condensed steam from fumaroles.

The Institute of Geological and Nuclear Sciences, in conjunction with The University of Auckland, The University of Waikato, Victoria University of Wellington and The University of Hawaii has embarked on an ambitious research programme to study the ecology and biodiversity of New Zealand's extreme environments. In particular, we are interested in investigating the relationship between extremophile diversity, geochemistry, and mineralogy, i.e., the geodiversity of extreme environments.

Our studies to date have included: preliminary phylogenetic studies of thermophile biodiversity in terrestrial geothermal systems from the Taupo Volcanic Zone; field-based experiments on silica growth rates and textural development in these systems; determination of trace metal zonations in microstromatolitic sinters formed by mineralization of thermophilic biofilms; and laboratory-based experiments to ascertain the role of bacteria in structural development of sinter textures.

Field studies of sinter growth rates and textural development have shown that microbes are not inducing precipitation where it should not occur based on calculated mineral saturation indices. The rate of precipitation is correlated with silica supersaturation but pH can alter this relationship. Textural preservation is related to initial silica spherule size and the effects of Ostwald ripening. LA-ICP-MS measurements of trace metal contents in natural thermophilic microstromatolites have shown enrichments in As, Sb, W, Tl, Pb and Au in organic/clay-rich layers that differ from those found in adjacent unconsolidated mud deposits. Also, heavy metal enrichments are negatively correlated with Fe and Mn concentrations. This suggests that: the microstromatolites are preserving a record of spring chemistry over time; and that thermophilic biofilms are influencing metal enrichment. Laboratory experiments were successful in producing thin silica laminae in the absence of bacteria and suggest that thermophilic biofilms, in some cases, postdate laminae development. The development of spicular textures, however, appears to be dependent on the presence of thermophilic microorganisms. The results of these experiments have implications for the interpretation of silica laminate texture and chemistry in fossil and extraterrestrial geothermal deposits.

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## *Geothermal*

### **Chemistry of the Rotorua Geothermal Field**

Ed Mroczek<sup>1,4</sup>, Mike Stewart<sup>2</sup>, Brad Scott<sup>1</sup> and Dougall Gordon<sup>3</sup>

<sup>1</sup>*Institute of Geological and Nuclear Sciences, Wairakei.*

<sup>2</sup>*Institute of Geological and Nuclear Sciences, Wellington.*

<sup>3</sup>*Environment Bay of Plenty, Whakatane.*

<sup>4</sup>*e.mroczek@gns.cri.nz*

The chemical and isotopic evidence incorporating the historical and recent well and spring results supports previous work that indicates that at least two separate plumes make up the overall Rotorua system. The primary upflow is to the east of the Rhyolite Domes, and then subsequently flows Southeast to Whakarewarewa. The smaller separate upflow to the Kuirau area is chemically distinct, although the geological evidence suggests that they are hydrologically connected. Excessive exploitation of one is likely to cause significant changes in the primary upflow that supplies Whakarewarewa.

The Whakarewarewa springs do not appear to be fed directly by a primary upflow and consequently the recovery has been mixed as the hydrology between the upflow and the surface outlets are influencing conditions. However recovery has been particularly notable at Parekohoru and Pohutu, but also evident for Okianga Geyser, Ngararatuatara and THC Blowout, with increases in aquifer (geothermometer) temperatures and a greater proportion of deep geothermal fluid being discharged. However in the northern area of the field at Kuirau Park the chemical evidence shows that the fluids discharged now match those discharging in the early 1960s and it is probable that this part of the field is near full recovery.

The shallow aquifer feeding the wells over the last decade shows relatively minor changes in reservoir chloride and small increases in heat (~16°C). This indicates stability and no deleterious processes are affecting the Rotorua Geothermal Field.

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## *Minerals*

### Acid-sulfate alteration of rocks of andesitic composition in a pressure-oxidation autoclave, Macraes mine, Otago.

Dave Crow

*Geology Department, University of Otago, PO Box 56, Dunedin, New Zealand*

Gold extraction at the Macraes mine involves concentration of pyrite and arsenopyrite, oxidation of those sulfides, then cyanidation. The ore concentrate is predominantly Otago Schist host rock (andesitic composition) with up to 15% sulfides. The oxidation step is conducted on an ore concentrate slurry in an autoclave at 225°C and 3800 kPa oxygen gas pressure, with continuous feed. The slurry takes c. 1 hour to pass through the autoclave, during which time the sulfides are almost completely oxidized. Sulfide oxidation causes strong acidification of the slurry, which is maintained at pH of 2-3 by addition of CaCO<sub>3</sub>. Scales form on walls in the autoclave, with minerals reflecting progressive oxidation and alteration of the ore through the system. The schist in the ore feed has mineralogy similar to propylitically altered andesite: quartz, albite, muscovite, chlorite, and pyrite. Muscovite undergoes almost complete dissolution, with associated precipitation of quartz and alunite, (KAl<sub>3</sub>(SO<sub>4</sub>)<sub>2</sub>(OH)<sub>6</sub>). Other principal minerals deposited and discharged include anhydrite (and/or gypsum), jarosite (KFe<sub>3</sub>(SO<sub>4</sub>)<sub>2</sub>(OH)<sub>6</sub>), hematite (and/or amorphous iron oxyhydroxide), and amorphous arsenates. Dissolved ferrous iron passes right through the autoclave, and variably hydrated Fe<sup>2+</sup> and Fe<sup>3+</sup> sulfate minerals, including rozenite & szolmonokite (both FeSO<sub>4</sub>.hydrate), and ferricopiapite (Fe<sub>5</sub>(SO<sub>4</sub>)<sub>6</sub>O(OH).hydrate), are formed along the way. The autoclave chemical system resembles acid-sulfate hydrothermal activity in geothermal systems and high-sulfidation epithermal mineral deposits formed in arc environments. These natural acid-sulfate systems are pervaded by volcanic vapours in the near-surface environment, where widespread dissolution of host rocks occurs and deposition of quartz, alunite, and anhydrite is common. Some of the volume loss associated with these natural systems may be due to dissolution of soluble sulfate minerals by later-stage groundwater incursion.

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## *Geothermal*

### **Geochemical monitoring before and during seven years of power generation at Ngawha, New Zealand**

Richard B Glover<sup>1</sup> and Tricia M Scott<sup>2</sup>

<sup>1</sup>*Glover Geothermal Geochemistry, Auckland, New Zealand [ggg@pl.net](mailto:ggg@pl.net)*

<sup>2</sup>*NZ Environmental, Kerikeri, New Zealand*

The main production reservoir contains liquid at 230°C, 1250 g/t chloride, and about 1.5 wt% carbon dioxide. Three typical areas of spring discharge are found viz: Spa, Waiariki and Tiger. The highest chloride water (ca. 1180 g/t) is observed at Jubilee Bath in the Spa area, evidence of the least dilution of the deep water. Waiariki baths (e.g. Universal contains ca. 260 g/t) are more dilute and are classified as bicarbonate water. Tiger bath (ca. 400 g/t Cl and ca. 930 g/t SO<sub>4</sub>) is typical of acid sulphate springs where the deep water is diluted with water containing sulphate formed from oxidation of hydrogen sulphide.

Linear regression of chemical concentrations are used to determine trends with time. The only significant trend in bath water chemistry is decrease of chloride in Universal bath at 3% per annum. Tiger increases in sulphate when chloride decreases confirming that sulphate is the main constituent of the diluting water, However, no significant linear trend is observed.

Over the past seven years, from July 1998 to March 2005, ca 23 Mt of fluid have been produced by the wells (and reinjected). Although some of the data show a large scatter, observed changes are consistent with less deep water and/or more steam and gas reaching the surface features. The production wells, NG9 and NG12 are now discharging some reinjected fluid as shown by constant chloride and decreased carbon dioxide. NG9, closer to the reinjection well, shows more change than NG12.

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## *Geothermal*

### **Diurnal biogeochemical cycles downstream of Champagne Pool, Waiotapu.**

James Pope.<sup>1</sup> David McConchie<sup>2</sup>, Malcolm Clark<sup>3</sup>, Kevin Brown<sup>4</sup>,  
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Champagne Pool, the largest spring in the Waiotapu Geothermal Field, discharges sulphide and trace element rich geothermal fluids that flow for 200m over sintered terraces with minimal dilution from other springs or surface water. The sinter terrace hosts a diverse microbial community including several species of sulphur oxidising and cyanobacteria.

Samples were collected and physiochemical parameters measured at five sites between Champagne Pool and the end of the sintered drainage area every two hours throughout a 24 hour period. The three downstream sites have systematic diurnal chemical variations whereas the two upstream sites do not display diurnal chemical variation. At the three most downstream sites, daytime increases in the concentration of dissolved As, Sb and Tl coincides with peak photosynthetic dissolved oxygen (DO) concentrations. Field observations and modelling indicates that sulphur, orpiment, stibnite and possibly carlinite, or amorphous varieties of these minerals, precipitate at night within Champagne Pool and on some of the sinter terrace area. During the day, DO from photosynthesising bacteria is sufficient to enable biologically catalysed oxidation of sulphides and sulphur that precipitate at night. At the two most downstream sites, sharp decreases in pH and increases in sulphate concentration occurs during the day. At these sites the concentration of other trace elements including Be, Ba, and Sr increases slightly during the day. Daytime increases in the concentration of these trace elements probably relate to the lower daytime pH disrupting adsorption to sinter substrate material or causing slight dissolution of alumino-silicates or sulphates within the sinter.

These observations and interpretations demonstrate that microbial activity strongly influences chemistry within the Champagne Pool drainage, for example almost all the Tl and Sb released from the immediate spring area is due to microbial activity. These data have implications for sampling programmes within geothermal areas and for other environments where reduced mineral species could interact with photosynthetic biological processes such as estuaries, wetlands and mine sites. Within these environments, short term (24 hr) temporal variations in

chemistry could be substantial and the implications of the time of sample collection should be thoroughly examined.

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## *Environmental Geochemistry*

### **Early diagenesis – A timebomb for lakes (II)**

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Four years of study of Rotorua lakes sediments has shown the presence of a very active diagenetic system whereby the accumulating sediments become anoxic with depth of burial resulting in reduction of iron and manganese and the release of almost all of the adsorbed trace elements. These migrate along a diffusion gradient towards the lake bottoms. Where the lake waters are oxygenated, reoxidation of the iron and manganese results in re-adsorption of much of the diffusing trace elements, resulting in high concentrations in the upper few centimeters of the sediment column. Where the waters are seasonally anoxic the iron, manganese and mobilized trace elements are released into the hypolimnion. Diffusion out of the hypolimnion into the thermocline has resulted in reoxidation and precipitation of large quantities of iron and manganese forming beds of manganese nodules in Lake Rotoiti in less than a decade. On seasonal turnover of the lakes very large quantities of phosphate and ammonium nitrogen are released into the photic zone in initiating further algal blooms. This problem appears to be steadily getting more pronounced and remains a serious threat for a number of lakes which have not yet experienced algal blooms.

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A magazine recently ran a "Dilbert Quotes" contest. They were looking for people to submit quotes from their real-life Dilbert-type managers.

Here are the first four (more of the top ten finalists to follow):

1. As of tomorrow, employees will only be able to access the building using individual security cards. Pictures will be taken next Wednesday and employees will receive their cards in two weeks. (This was the winning quote from Fred Dales, Microsoft Corp. in Redmond, WA).
2. What I need is an exact list of specific unknown problems we might encounter. (Lykes Lines Shipping).
3. E-mail is not to be used to pass on information or data. It should be used only for company business. (Accounting Manager, Electric Boat Company).
4. This project is so important, we can't let things that are more important interfere with it. (Advertising/Marketing manager, United Parcel Service).

[provided by G L Lyon]