Newsletter

of the

International Association of Geochemistry and Cosmochemistry

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The International Association of Geochemistry and Cosmochemistry is a Nonprofit Organization

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NEWS FROM THE ASSOCIATION

The IAGC is undergoing rejuvenation in four key directions this year:

1) New Council members: Every four years, Council members come up for re-election. They can serve a maximum of eight years and, this year, nine new Councillors must be elected at the annual Council Meeting, to be held in conjunction with the International Geological Congress (IGC) in Florence, Italy, on August 20th.

2) Name change: The IAGC is expecting to change its name to IAAGC, the International Association of Applied GeoChemistry. This move has been proposed by Council member Russell Harmon so that our name more accurately reflects our objectives, members interests and journal (*Applied Geochemistry*). It has the strong backing of most of Council but we would like to hear your opinion before proceeding.

3) Statutes: Together with the name change, there must be a concomitant change in our Statutes which were written over 20 years ago and only amended slightly since then. The revised Statutes are reproduced in this Newsletter (page 16) and members are invited to comment prior to the Council meeting. The new Statutes will be voted on at this meeting. More can be found about this change on page 2.

4) Membership: Various options of increasing IAGC membership will be discussed at the meeting including free membership if an existing member sign up a new member, a free subscription to *Applied Geochemistry* for every 5 new members that can be signed up, greater presence at conferences, etc.

IAGC Business Office Activities

The Business Office has had a busy six months since the last issue of the Newsletter (#39) in October 2003. Renewal notices for IAGC dues and *Applied Geochemistry* subscriptions for 2004 were included as paper copies in the Newsletter for those whose e-mail address we did not have. The .pdf version of the Newsletter was sent out by e-mail to about 75% of our members together with a separate file containing the renewal notice. So far, about 300 members have renewed and a final 'reminder' will be sent out shortly to the rest.

This Newsletter is being sent to all 2003 and 2004 members whether or not you are paid up for 2004. However, the next Newsletter (#41) will go only to 2004 members.

Lack of receipt of *Applied Geochemistry* issues for 2003 was reported by a few members over the last six months but these have been resolved with the thorough and prompt assistance of Catherine Parlow in the Florida office of Elsevier (the publisher).

The Business Office has been receiving five copies of each monthly issue of *Applied Geochemistry* for dealing with missing-issue complaints by subscribers. These issues go back to 2002 (volume 17).

Any IAGC member that is paid up and has a subscription to *Applied Geochemistry* for 2003, but is not receiving copies of *AG* should contact the Business Office (address on page 14).

For a limited time only, until stocks run out, the Business Office is offering to mail out missing issues of volumes 17 & 18 to fill in the gaps of members' collections, free of charge! Let us know if you are missing an issue. Note that we cannot replace large numbers of missing issues - members should contact the Business Office separately to try and arrange this.

Payments from the IAGC (Pinawa) bank account have been made to Elsevier to support the IAGC's 10 gratis members in developing countries (set up

THE FUTURE OF THE IAGC

Members are invited to attend IAGC meetings to be held in conjunction with the International Geological Congress in Florence, Italy, in 2004, August 20-28. A new Council will be voted in an Aug. 20th and Elsevier will brief Council and interested members on future directions, issues and ideas related to the publication of *Applied Geochemistry*.

by Gunter Faure in 2002) and to cover the cost of subscriptions to *AG* for Honorary Members.

CALL FOR NOMINATIONS

Positions on the Publications Committee

Two IAGC ordinary members are needed to serve on the Publications Committee chaired by Nick Sobolev to help in negotiating a new contract with Elsevier Science for the IAGC member rates for subscription to *Applied Geochemistry*. If you are interested in serving, please contact Nick (addresses at end of Newsletter).

CHANGES TO THE STATUTES

Although the IAGC Council adopted a set of revised Statutes at its meeting in Davos, Switzerland in August 2002, those Statutes contained several inconsistencies and contradictions. Also, they do not address the orientation, operation, and governance of the Association to the extent that many of the Officers and Councillors deem necessary if the Association is to move forward from its largely static position within the geochemistry community and grow over the long term. Based upon a member petition to Council in February '04, the set of new Statutes presented on page 16 of this Newsletter will be brought to the IAGC Council for a ratification vote at its upcoming business meeting to be held in Florence, Italy during the 32nd International Geological Congress in August '04. Any member wishing to comment on these Statutes may do so by providing comments by e-mail, facsimile message, or letter to Russell Harmon (harmon@aro.arl.army.mil; 919-549-4310; US Army Research Office, PO Box 12211, Research Triangle Park, NC 27709-2211, USA), or to any other Association Officer or Council Member (see the back pages of the Newsletter for names and contact information) no later than 1 June '04. All member comments will be compiled and distributed to Council Members a month before the August Council meeting.

NOMINATIONS FOR IAGC COUNCIL

R.S. Harmon
(Chair, IAGC Nominations Committee)

The Statutes of the IAGC state that: "The Council shall consist of the President, Vice President, Secretary, Treasurer, Past President, Executive Editor, and ten ordinary members, all of whom shall be elected by the Council. No two of the ordinary members of the Council shall be from the same country. Ordinary members shall be eligible for re-election for one additional term." Due to a variety of circumstances, nine ordinary Council positions will fall vacant by the time of the next Council meeting in Florence, Italy, this coming August.

Council Member Russell Harmon was appointed Chair of the Nominations Committee by the Council at its last meeting in May 2003. A 4-person committee was formed, consisting of Council member Jan Kramers of Switzerland, Rolf Hallberg of Sweden, and June Mirecki of the USA. The Association membership was solicited for Council nominations and each member of Council put forward at least one candidate. The final slate of Council candidates consisted of 13 nominees from 11 countries: N. Clauer – France, S. Frape – Canada, J, Gray – USA, A. Herczeg –

Australia, C. Koeberl – Austria, B. Lyons – USA, K. Notsu – Japan, M. Novak –Czech Republic, A. Parker – UK, W. Puttman – Germany, R. Raiswell – UK, A. Roychoudury – South Africa, and O. Selinus – Sweden. The new Council members will be ratified at the August Council meeting based upon a majority vote of the retiring Council'

WORKING GROUP ACTIVITIES

Thermodynamics of Natural Processes (G. Kolonin)

The main event in 2003 of the Working Group (TNP) was the assistance of participation of Russian and other geochemists in the traditional International Symposium on Hydrothermal Reactions (ISHR-7) held in Changchun, China during December 14-18.

Oral presentations were given by four geochemists from Moscow, Novosibirsk and Vladivostok (Prof.'s V.M. Valyashko and A.A. Obolensky, Dr's G.G. Pavlova and G. Likhoydov). They centred on principal aspects of physical-chemical conditions of hydrothermal minerals and ore formation based on new experimental and thermodynamic data.

It was really worthwhile to support Chinese colleagues especially taking into account the enforced change of date of the Symposium (from August to December) because of the SARS epidemic in their country. (Unfortunately, other than Chinese and Russian participants, only a group of Japanese scientists and individual researchers from India, Germany and a few other countries were able to get together in these circumstances).

Water-Rock Interaction (Y. Kharaka)

The 11th International Symposium on Water-Rock Interaction (WRI-11) will be held in Saratoga Springs, New York, USA from June 27 to July 2, 2004. In addition to pre-session field trips, the Symposium addresses all aspects of Water-Rock Interaction including recent advances in biogeochemistry, weathering system science, geochemical modelling, radioactive nuclide chemistry, magmatic processes and degassing, environmental geochemistry, geochemical spectroscopies and microscopies, and isotope geochemistry.

The Symposium is sponsored by a number of organisations including the Water-Rock Interaction Working Group of the IAGC.

WRI-11 organizers are expecting about 500 attendees as they have received over 330 manuscripts submitted by scientists from over 35 countries. The papers include theoretical, analytical, laboratory, and field-based studies of processes spanning from high- to low-temperature environments and from abiotic to biotic processes.

For detailed information about this Symposium, including registration for WRI-11 and the pre session field trips, please go the WRI-11 web site at: http://app.outreach.psu.edu/wri/ or contact the Secretary General for WRI-11, Prof. Susan Brantley (Penn State) at: **Susan Brantley <brantley@essc.psu.edu>**

Geochemistry and Disease (R. B. Finkelman)

Interest in "Medical Geology" continues to accelerate.

The IUGS Medical Geology Working Group has raised its visibility by morphing into the International Medical Geology Association (IMGA) with a director, two co-directors, and six Councillors. They have expanded their web page http://home.swipnet.se/medicalgeology/ and continue to publish an informative newsletter. For the past several years there is a close, mutually beneficial relationship between the IAGC and the IMGA. IAGC members have played a prominent

role in helping to expand this organisation and spread the word about Medical Geology.

The International Year of Planet Earth will soon be proclaimed through the United Nations. This joint venture of the IUGS and UNESCO has selected Earth and Health as one of the eight themes that will be promoted. Again, Geochemistry and Disease Working Group members will be actively involved in this theme area.

Two new books, both titled Medical Geology, will be published this year. A 900-page book edited by Olle Selinus and co-edited by several members of our Working Group will be available in time for the IGC meeting. A second book by Dr. M.M. Komatina will be available in April.

Medical geology short courses were presented at the International Society of Environmental Geochemistry meeting held in Edinburgh in September, 2003. More than 70 people attended the short courses from 25 different countries. Four of the attendees were students who were supported by IAGC grants. Short courses were also presented in Uruguay and Brazil in October and in Australia (Canberra) and Malaysia in December, 2003.

This year medical geology short courses are scheduled for South Africa in June, in Taiwan in October, and in Australia (Perth) in December. Short courses in India and Canada are planned but not yet scheduled.

Geochemical Training in Developing Countries (U. Aswathanarayana)

A refresher course for earth science teachers was given in Hyderabad at the Jawaharlal Nehru Technological University, November 3-15, 2003. The focal theme was 'Natural Resources Management, Environment and Employment'. The course was sponsored by the Indian Academy of Sciences, Bangalore, International Association of Geochemistry & Cosmochemistry and the Geological Society of India. The course directors were Prof. U. Aswathanarayana and Prof. K.V. Subbarao.

This course was based, in part, on a common problem in the geosciences, best exemplified by the Dept. of Geology, University of Udaipur, Rajasthan, which reportedly has 25 senior teachers but no more than two students for M.Sc. Geology. This situation is obviously unsustainable. In tune with the objective of broad basing of geoscience instruction, the course participants included not only teachers in geoscience, but also in civil engineering, environmental science, and economics. The course was interactive, and all participants were required to make presentations.

A full report on the course and roundtable discussions can be obtained from Dr. Aswathanarayana (e-mail address: uaswathanarayana@yahoo.com).

Global Geochemical Baselines for 2003 (D. Smith)

There has been significant progress within a number of countries over the past year. In Southern India, sampling has been completed on 12 cells – about one tenth of the total for the entire country – as part of a pilot study led by the National Geophysical Research Institute (NGRI). The data have recently been published and have attracted considerable attention.

Dr David Smith of the U.S. Geological Survey and Co-Leader for the IUGS/IAGC Working Group spent November 16-22, 2003 in Hyderabad, India participating in a workshop titled "Global Geochemical Baselines for Environmental Management in India". This workshop, organised by the Working Group's

regional co-ordinator in India, Dr. Pradip Govil, was devoted to developing final protocols for multi-media sampling on the Global Reference Network in India. The primary organizations participating in this project will be the NGRI, the Geological Survey of India, the Bhabha Atomic Research Centre, and the Wadia Institute of Himalayan Geology. Field work will begin in 2004. Proposals have been submitted for sampling to begin in Kenya, Uganda and Tanzania. Some of the most significant developments are still occurring within the 11 member countries of the Coordinating Committee for Geoscience Programmes in East and Southeast Asia (CCOP). A geochemical mapping project, to be co-ordinated through the CCOP, has been approved by all member countries through the CCOP Steering Committee. An inventory of data is nearing completion and a series of training sessions are planned pending funding. An Expression of Interest has recently been submitted to the IUGS with the intention of using the funding to hold workshops in India and Thailand to help promote Working-Group-related activities.

The IUGS/IAGC Working Group held its annual Business Meeting in Edinburgh, Scotland on 9 September 2003 in conjunction with the 6th International Symposium on Environmental Geochemistry. Work has also been progressing on updating the 'field manual' (Salminen *et al.*, 1998) to include advice on sampling in terrains not originally covered, including mountainous, tropical and karstic terrains.

Within Europe, work has been continuing on the Forum of European Geological Surveys (FOREGS) contribution to the project. Sampling was completed within all countries participating in the FOREGS programme in 2001, although there are now plans to extend the sampling in Iceland. All analyses have been completed over the past year, and all necessary quality control checks have recently been completed. Data compilation and management processes are well underway, and the first set of final maps has been prepared for interpretation.

Significant progress has been made in writing some of the introductory and background texts for the Geochemical Atlas of Europe. The FOREGS group held its annual business meetings in Dublin Ireland in March 2003 with a supplementary meeting conducted in Edinburgh in September. Meetings of the FOREGS Quality Control Group and the Interpretation Group were held in Helsinki in May 2003 and Edinburgh in September 2003, respectively.

The Working Group is convening a workshop at the 32nd International Geological Congress in Florence, Italy during August. The title of the workshop is "Global Geochemical Baselines (IUGS/IAGC/FOREGS)". This workshop will focus on the interpretive geochemical map products from the FOREGS geochemical baselines programme. The annual business meeting of the Working Group will also be held in Florence at this time.

Work will continue on the manuscript for the Geochemical Atlas of Europe with a draft ready for review in late 2004 or early 2005.Pending funding from IUGS, workshops will be held in India and in Thailand to promote activities in India and the CCOP countries related to global-scale geochemical mapping.

Collaborative pilot studies will begin in Canada, the United States, and Mexico to develop protocols for a soil geochemical/biogeochemical survey of North America. A field training course for the East African sub project will be held in Tanzania in July 2004.

INTERNATIONAL INGERSON LECTURE

This year's International Ingerson Lecturer has been awarded to Professor Stephen Moorbath who will deliver the Lecture entitled
"Oldest Rocks, Earliest Life, Heaviest Impacts, and the Hadean-Archaean Transition"
at the International Geological Congress, in Florence, Italy. The exact date and time is not yet fixed, but it will be held as a separate event and IGC attendees will be notified.

COMING EVENTS

IAGC-Sponsored Meetings

WRI 11

The IAGC Working Group on Water-Rock Interaction (Chairman, Yousif Kharaka, Secretary-General Susan Brantley) is holding the Eleventh International Symposium on Water-Rock Interaction to be held in Saratoga Springs, New York, USA, June 27-July 2, 2004.

More details and addresses can be found on page of this Newsletter.

2004 IGC

The 2004 International Geological Congress will take place from 20-28 August 2004 in Florence, Italy, and will include the IAGC-sponsored general session G-04.01 on Frontiers in Analytical Geochemistry. The frontiers of research are rapidly moving forward as a result of revolutionary advances in technology. Complete information about the Congress is available from the web site http://www.32igc.org. Session convenors are Russell Harmon, Jochen Hoefs & Riccardo Vannucci.

The session on Frontiers in Analytical Geochemistry, will focus on the applications of recent advances in technology for in-situ, spatially resolved chemical and isotopic analysis of geologic and environmental samples. This session will highlight the latest technical developments and their contribution to a better understanding of natural processes across a broad spectrum of both organic and inorganic geochemistry and cosmochemistry.

We anticipate a publication as a special volume of the journal *Applied Geochemistry*.

Other Meetings of Interest

IAEA Meeting in Vienna

A Joint European Stable Isotope Users group Meeting is being organized in Vienna, 30 August – 3 September 2004. For details see http://chemsrv0.pph.univie.ac.at/JESIUM/.

Applied Isotope Meeting in Paris

The International Workshop on the Application of Isotope Techniques in Hydrological and Environmental Studies will be held in Paris, France, September 6-8, 2004. It honours the memory of Jean Charles Fontes – ten years after his death.

More information can be obtained from Jean-Luc Michelot, "OrsayTerre", CNRS-Université de Paris-Sud, Orsay (e-mail: michelot@geol.u-psud.fr).

Goldschmidt Meeting

Registration for Goldschmidt 2004, Copenhagen, 5 to 11 June 2004, is open now on the web site www.goldschmidt2004.dk
Be sure to register for PLENARY DAY! The cost is included in the registration fee, but we need confirmation that you want your seat. Extra spaces will be offered to the public. 'A Celebration of Geochemistry' will be festive and exciting. It features well-known scientists who will give general talks on current hot topics. The Awards and Medals of the sponsoring societies will be presented and the day will finish with an evening in Tivoli Gardens, Copenhagen's famous park (entrance is free for participants).

Information about field trips and workshops before and after the conference is also on the web site. Click on the menu item SCIENTIFIC PROGRAM for full lists.

Environmental Geochemistry in the Tropics

The 4th International Symposium on Environmental Geochemistry in Tropical Countries will take place in Búzios, Rio de Janeiro State, Brazil, during October 25th to 29th, 2004. Consult the web site http://www.uff.br/geoquimica/isegtc2004 to obtain information about this Symposium.

Australia and Isotopes

The 8th Australasian Environmental Isotope Conference will be held in Melbourne from Monday 29 November - Wednesday 1 December 2004. This is the latest in a long-running series of conferences dedicated to the application of stable and radiogenic isotopes to studies of environmental processes.

As with previous conferences in this series, we invite presentations on applications of stable, radiogenic, and cosmogenic isotopes to understanding the natural environment. Topics include...

- Climate and environmental change
- Groundwater and surface water
- Soils
- Landscape evolution
- Applications of cosmogenic isotopes
- Dating
- New analytical techniques and applications

Further information can be found at http://www.earthsci.unimelb.edu.au/conferences/index.html

CONTRIBUTED ARTICLE: Options for the Disposal of High-Level Nuclear Waste

Mel Gascoyne

One of the most pressing demands on countries who generate electricity by nuclear power is the disposal of high-level nuclear waste. A number of methods have been suggested and, in some cases, tested, over the last 50 years for the disposal of (primarily) spent nuclear fuel from commercial power reactors. These methods sometimes require considerable data on the geoscientific characteristics of a potential disposal site, not least of which is geochemistry. The disposal methods are described below together with summaries of their current status.

This article is derived and modified from a background paper by P. Richardson and M. Hill for the Canadian Nuclear Waste Management Organisation (NWMO), published by NWMO in 2003. It is presented here for the general information of IAGC members.

Disposal in Space

The objective of this method is to permanently remove radioactive waste from the Earth by ejecting it into outer space. Alternative destinations that have been considered include the sun, orbit around the sun, and ejection beyond the solar system. Use of this method for disposing of small amounts of the most toxic waste has been suggested. This method has never been included in any major research and development program. Opposition to disposal in space has been reinforced by the Challenger and Columbia accidents.

Emplacement in Deep Boreholes

In this method, solid packaged wastes would be placed in deep boreholes drilled from the surface to depths of several kilometres with diameters of typically less than one metre. The waste containers would be stacked one on top of one another in each borehole and would be separated from each other by a layer of bentonite or cement. The borehole would not be completely filled with wastes. The top two kilometres would be sealed with materials such as bentonite, asphalt or concrete.

This concept has been examined in a number of countries (eg Sweden, Finland, Russia) as a possible alternative to a deep repository. Boreholes could be drilled offshore as well as onshore in many types of rock, which expands the range of locations that could be considered for disposal using this concept. Proponents argue that related long-term risks to people and the environment would be very low. A number of significant technical questions remain outstanding, however, and would necessitate extensive research to answer. This method is primarily of interest in countries facing the disposal of small quantities of high-level waste.

Direct Injection

This method involves the injection of liquid radioactive waste directly into a layer of rock deep underground. Although used for the disposal of liquid hazardous and low-level waste in the US in the past, this technique has only ever been used for liquid high-level waste in the former Soviet Union, at a number of locations, usually close to the waste generating sites. Direct injection requires detailed knowledge of subsurface geological conditions, as it does not incorporate any man-made barriers. There would be no control of the injected material after disposal and retrieval would be impossible. There are many technical unknowns that would require extensive research to gain the degree of confidence that this method would be appropriate in any given site location. Although the option would not contravene international conventions it would not be consistent with the spirit of international guidance on the long-term management of radioactive wastes. Current published assessments

indicate no substantive advantages of this method and it is not being pursued in any country as a means of dealing with an entire national inventory of used nuclear fuel.

Rock Melting

In this method, the waste is first placed in liquid or solid form in an excavated cavity or a deep borehole. In theory, the heat generated by the wastes would then accumulate resulting in temperatures sufficient enough to melt the surrounding rock and dissolve the radionuclides in a growing sphere of molten material. As the rock cools it would crystallize and incorporate the radionuclides in the rock matrix, thus dispersing the waste throughout a larger volume of rock. There are variations of this method whereby the heat generating waste would be placed in containers; the rock around the containers would melt thus sealing the waste in place.

Research was carried out on this method in the late 1970s and early 1980s, when it was developed to the level of engineering design. The design involved a shaft or borehole which led to an excavated cavity at a depth of 2-5 kilometres. It was estimated, but not demonstrated, that the waste would be immobilized in a volume of rock one thousand times larger than the original volume of waste. Another early proposal was to use weighted containers of heat-generating wastes that would continue to melt the underlying rock, allowing them to move downwards to greater depths with the molten rock solidifying above them. There was renewed interest in this method in the 1990s in Russia, particularly for the disposal of limited volumes of specialized waste such as plutonium. Russian scientists have also proposed that HLW, particularly excess plutonium, could be placed in a deep shaft and immobilized by a nuclear explosion, which would melt the surrounding rock.

There have been no practical demonstrations that rock melting is feasible or economically viable. This method is not being investigated in the national program of any country.

Sub-seabed Disposal

In this method, radioactive waste containers would be buried in a suitable geological setting beneath the deep ocean floor. Sub-seabed disposal was investigated extensively in the 1980s.

The main disposal concept involves the use missile-shaped canisters called “penetrators” that hold the solid waste, are dropped from ships, and would bury themselves to a depth of a few metres or more in the sediments on the ocean floor. The disposal sites would be ones where the sediments are plastic and have a high capacity to absorb radionuclides, and where the water is a few kilometres deep. The idea behind the concept is that the waste form, inner canister, penetrator and sediments would provide sufficient protection to prevent the release of radionuclides into the ocean for thousands of years or more. When release finally does take place it would occur very slowly and there would be substantial dilution. An alternative concept would draw on deep sea drilling technology to stack waste packages in holes drilled to a depth of 800 metres, with the uppermost container about 300 metres below the seabed.

Research on sub-seabed disposal effectively ceased in the early 1990s when it became clear that there would always be intense political opposition. Ocean access to a sub-seabed repository is now prohibited by international conventions.

An alternative concept that has emerged is to access a sub-seabed location via on-land shafts and drifts. This is the situation in Sweden where a deep geological repository is being examined that would be located deep beneath the ocean floor. In this instance, the ocean itself is seen as a last line of defence. The thought is that if contaminants were to escape and move to the ocean environment, their volume would be small and the buffering and diluting capacity of the ocean would mitigate consequences.

Disposal at Sea

This method consists of placing packaged waste on the bed of the deep ocean. The packaging would consist of canisters designed to last for a thousand years or more. The waste would be in a solid form that would release radionuclides into the ocean very slowly when the canisters fail. The site would be one where the water is a few kilometres deep, so that the waste would not be disturbed by human activities and so there would be substantial dilution of radionuclides before they reach the surface environment. Sea disposal was investigated by the Nuclear Energy Agency's Seabed Working Group but not in the same detail as sub-seabed disposal. It would be an extension of the 'sea dumping' method that was used for disposal of solid low-level radioactive waste until the early 1980s and that is now prohibited under international conventions. Sea disposal is also prohibited by international conventions and is not now included in any national or international R&D programs.

Dilute and Disperse

The method would involve dissolving the fuel in acid, neutralizing the solution and discharging it slowly down a pipeline into the sea. The discharge site and rate would be such that radiation doses to people never exceed internationally accepted limits. Another possibility would be to transport the fuel solution by tanker to the open ocean and release it there. Dilute and disperse differs from all the other storage and disposal methods in that there is no element of containment of the waste and isolation from the environment. It has never seriously been proposed for spent nuclear fuel because sea disposal is prohibited by international conventions.

Disposal in Subduction Zones

This method was initially proposed in the 1980s. In theory, it involves placing the waste in a subducting or descending plate of the earth's crust. As subduction zones are invariably offshore, this concept can also be considered as a variant of emplacement in the sea or beneath the seabed. Either tunneling or deep sub-seabed boreholes could theoretically be used to emplace the waste close to an active subduction zone. Free-fall penetrators, as proposed for the sub-seabed option, could also be used.

Lack of confidence in predicting the fate of the wastes has been the main reason why little attention has been paid to disposal in subduction zones. Concerns have been expressed that waste might return to the surface environment via volcanic eruptions. It has also been suggested that this method would be seen as a form of sea disposal and hence would be prohibited by international conventions. No national or international program is currently examining this option in any way.

Disposal in Ice Sheets

In this method, containers of heat-generating waste would be placed in very thick stable ice sheets, such as those found in Greenland and Antarctica. Three concepts have been suggested. In the "meltdown" concept, containers would melt the surrounding ice and be drawn deep into the ice sheet, where the ice would refreeze above the wastes creating a thick barrier. In the "anchored emplacement" concept, containers would be attached by surface anchors that would limit their penetration into the ice by melting to around 200-500 metres, thus enabling possible retrieval for several hundred years before surface ice covers the anchors. Lastly, in the "surface storage" concept, containers would be placed in a storage facility constructed on piers above the ice surface. As the piers sank, the facility would be jacked up to remain above the ice for perhaps a few hundred years. Then the entire facility would be allowed to sink into the ice sheet and be covered over.

There has been very little work on disposal in ice sheets because there has never been enough confidence about predicting the fate of the waste and because of the potential for release of radionuclides into the ocean. Disposal of radioactive waste in Antarctica is prohibited by international treaty and Denmark has indicated

that it would not allow such disposal in Greenland Disposal in ice sheets is not included in any national or international R&D programs.

Reprocessing; Partitioning and Transmutation

Reprocessing is a general term for applying chemical and physical processes to spent nuclear fuel whereas "processing" is taken to mean the preparation of fresh fuel before it goes into the reactor. Partitioning and Transmutation are specialized aspects of reprocessing.

These methods are included in the "some interest" category because reprocessing is in use in some countries, including France and the United Kingdom). It should be noted however that:

- no countries intend to employ reprocessing for civil waste management purposes alone
- reprocessing is now being phased out in the UK
- the scientific and technical foundation for transmutation is not yet sufficiently advanced for implementation in the near future
- these methods do not comprise a complete management option - the residual wastes need to be addressed.

The recovery and recycling of fissionable isotopes is the main reason for reprocessing fuel in countries operating LWRs (Light Water Reactors) in contrast to the heavy water CANDU system. France, Japan, the United Kingdom, and Russia reprocess fuel from LWRs; the US, which operates some 100 LWRs, does not.

Reprocessing technology was first developed and exploited in the nuclear weapons programs of the United States, the United Kingdom, and Russia and later in the military programs of France, China, and India. The aim was to extract weapons-grade plutonium-239 while the other main weapons material, uranium-235, was produced in uranium enrichment plants. This military-related investment in infrastructure has significantly influenced the choice of fuel cycle related infrastructure in countries that have subsequently initiated civilian nuclear power programs.

In recent years, the urgency for uranium recycling or for the recovery of plutonium for fast reactors has declined and overall interest in reprocessing has diminished. In August, 2003, British Nuclear Fuels Limited announced that it would close Britain's only reprocessing plant at Sellafield. At the current time, interest in reprocessing has switched from its fuel recovery role to the possibilities it offers for augmenting the waste management process.

Reprocessing is initiated after the spent fuel has cooled for a few years. The fuel is moved in large lead and steel casks to a reprocessing facility. There, it is dissolved in nitric acid while the volatile radioactive gases are carefully contained. Several processes of separating and segregating allow the isolation of different streams of products including: (1) useable uranium-235 and plutonium-239; (2) highly radioactive liquid waste; and (3) less radioactive solids, liquids, and gases. These processes are called "partitioning."

Reprocessing and partitioning merely re-arrange and recycle components. They do not reduce the quantity or toxicity of the nuclear fuel. It may be possible, in a further process, to actually transform some of the radioactive components into non-radioactive elements using nuclear reactions initiated by neutrons, protons, or even photons from lasers. This step is called "transmutation" meaning changing one element to another.

Successful transmutation could significantly reduce the time horizon of risk associated with spent nuclear fuel, unwanted nuclear weapons, and surplus plutonium. As a result, it is the subject of research programs in many countries including Japan, France, USA, Russia, the Republic of Korea, and Italy as well as the European Community. However, at present it is not a practical radioactive waste management solution.

Deep Geological Disposal

Disposal is the permanent placement of spent fuel with no intention of retrieval for future use. Deep geological disposal involves burying the spent fuel deep underground. This method is currently favored by many countries and by most international agencies.

The main challenge is to limit the potential for migration of radioactive and toxic contaminants away from the spent fuel. The dominant pathway of concern is through the groundwater flow system. Even if contaminant movement is exceedingly slow, say 1 m/year, in over 5,000 years, a distance of 5 km can be achieved. As a result, multiple barriers are integrated into system design. Such barriers currently include:

- the fuel pellet itself which is made of ceramic and retains almost all of the fission products;
- the zircaloy holding tube that seals in the pellets;
- the waste container of materials selected to prevent corrosion, cracking and perforation;
- multiple buffer zones surrounding the waste container;
- a host geological media that naturally limits contaminant movement over the long term.

If escape from the engineered containment occurs, contaminant transport is a function of the nature of: (1) the contaminants themselves; (2) the host rock, and (3) the groundwater flow system. Chemical, physical, and even electrical properties come into play. Several rock types are possible including granite, rock salt, sedimentary clay, and volcanic tuff and each of these media can be advantageous for different reasons. Obviously in a given country, the available geology limits the choice.

In Canada, the stable plutonic granites of the Canadian Shield have been the focus of investigation. In Germany, the feasibility of burial in rock salt formations has being assessed. Italy has examined clays, and the US federal government has made a commitment to Yucca Mountain, a tuffaceous host that is formed by the accumulation of glassy fragments from a volcanic eruption. The appeal of deep geological disposal lies in three factors: (1) responsibility passed to future generations is minimized; (2) capacity to withstand significant geological change and extreme events (storms, earthquakes, meteor impact, glaciations, variation in temperature) is significant; (3) capacity to withstand terrorism and collapse of social and political institutions is also great. However, while its “permanence” brings comfort to some, the same permanence makes it difficult to retrieve the spent fuel should future societies find value in it.

The original deep geological disposal concept included backfilling and sealing the repositories as soon as possible after waste emplacement. More recently, several countries are now adopting a “staged” approach where the final closure is postponed until many years into the future. In the interim, it remains possible to retrieve the spent fuel should that prove desirable. Doing so allows a period of time for research to be undertaken and technical change to take its course. During this period, monitoring systems allow examination of how effectively the system is functioning. These two approaches are referred to as the “early seal” and “late seal” options.

While the “late seal” approach maintains future options more effectively than the “early seal” approach and allows learning to continue, it also exposes the spent fuel to a higher degree of risk to the very factors that deep geological disposal is intended to protect against. Thus, a “late seal” approach adds additional expense through a requirement for much more stringent oversight.

Long-term Storage

Although not a 'disposal' method, some countries such as Canada, are considering long-term storage as an alternative to disposal of nuclear waste. Two options have been proposed: Centralized Extended Storage (CES) and Reactor-site Extended Storage (RES). Long term storage at a central site would require transport of the spent

fuel from the reactor sites. Storage facilities can be either located above or below ground.

Facilities above ground can be designed with varying degrees of longevity in mind. These vary from 'conventional' storage buildings that would need to be replaced every century or so, to more permanent 'mausoleums' or 'monoliths' designed to remain sealed and intact for perhaps a thousand or several thousand years - a degree of permanence that has been demonstrated by the Great Pyramids of Egypt.

Underground storage is envisioned to take place either by shallow burial or the use of caverns or tunnels, a few tens of metres beneath the surface. The goal is to enhance the degree of security and safety relative to above-ground methods while retaining the ease of fuel retrieval. An additional benefit would be reduced ongoing maintenance costs relative to above ground storage.

There is general agreement that provided strict standards of design, operation, and maintenance are followed, the risk posed by centralized storage facilities to the public would be low. Initial capital costs would be lower relative to deep geological disposal and retrieval would be easier. However, there is no doubt that these facilities would remain vulnerable to potential extreme events and social instability. Their integrity would be dependent on ongoing maintenance with oversight-related costs and responsibilities for future generations.

Reactor-site storage removes the need to transport the fuel to a centralized location. Furthermore, because facilities are many, the size of any one facility is reduced. As with centralized storage, above- and below-ground options exist and at least some designs and costs can be simply scaled down from the larger versions of centralized facilities. However, with many sites to deal with, a great variety of conditions must be factored into the design, construction, operation, and maintenance processes.

Above-ground storage facilities are now in place at reactors around the world and have been operational for a number of decades. However, the development of underground interim storage facilities for used nuclear fuel has not been widely practiced - most storage facilities are above ground. The best known example of an operating underground interim storage facility is the CLAB facility in Sweden, where used fuel is stored in pools some 30 metres below the surface. France is currently examining 'very long-term interim storage' options involving either near surface pools like CLAB or deeper drift-accessed facilities set in shallow hills.

Conclusions (MG)

Most countries with nuclear power programs are moving slowly towards deciding what to do with their fuel waste. Disposal of the waste appears to be best accomplished by constructing a deep geological repository in a tectonically stable rock environment. Granites, clay deposits, salt formations and volcanic tuffs are the rock types that are being investigated. However, long-term storage is being considered as a viable option by several countries but, ultimately, disposal must be undertaken. A compelling reason to go to full and final disposal is the argument that we should not be leaving the responsibility for disposal of our wastes to future generations. Also, how sure can we be that we will still have the same political and institutional controls that we have now in 100 years time (or even less)?

Because the successful disposal of nuclear waste in a deep geological environment relies so much on an understanding of geochemical processes, it is clear that 'applied geochemistry' will be one of the most important geoscience disciplines in the future of nuclear waste disposal.

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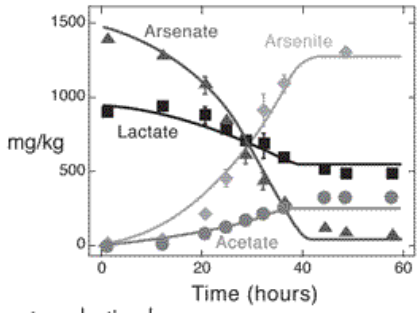
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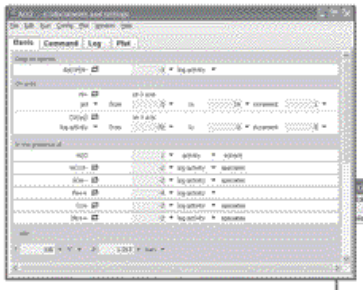
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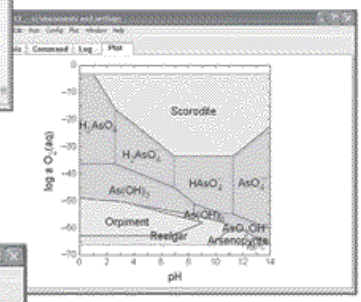
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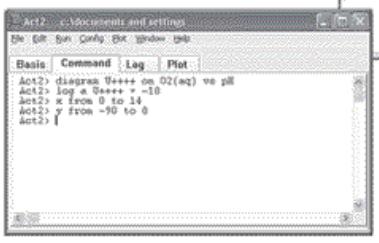
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STATUTES OF THE INTERNATIONAL ASSOCIATION OF

APPLIED GEOCHEMISTRY (IAAGC)

(to be ratified August 2004)

I. Name, Objectives, and Classes of Membership

A. Name

The organization shall be known as the International Association of Applied GeoChemistry (IAAGC), hereafter described as 'the Association'. The word 'geochemistry', where used hereinafter, shall be understood always to mean 'applied geochemistry' in its very broadest sense, *i.e.* the application of the techniques of analytical chemistry to understanding the earth and solving problems in the earth, atmospheric, hydrological, environmental, biological and ecological, medical, and forensic sciences.

B. Objectives

The principal objective of the Association shall be to foster cooperation in, and advancement of, the study of the broad field of geochemistry and its application to the earth, atmospheric, hydrological, environmental, biological and ecological, medical, and forensic sciences by:

1. Working with any interested group to sponsor conferences, symposia, workshops, and other types of meetings related to geochemistry;
2. Sponsoring a world-class publication in the area of applied geochemistry;
3. Appointment of official Association Working Groups to foster the study of specific areas of geochemistry that require, or would benefit from, international cooperation.

C. Membership

Membership of the association shall be of five (5) classes:

1. **Individual Members:** Individuals who are interested in any aspect of applied geochemistry and who pay the regular Association dues, as specified in Section V below under Finances.
2. **Sustaining Members:** Individuals or organizations particularly interested in the Association and its work and who make annual contributions that are substantially greater than the regular dues, as specified in Section V below under Finances.
3. **Life Members:** Individuals or organizations particularly interested in the Association and its work and who make a one-time dues payment of $250 or more.
4. **Honorary Fellows:** Individuals distinguished for their scientific contributions to geochemistry, or who have made significant and exemplary contributions to the Association over an extended period, may be nominated for Honorary Fellow status by the Nominations Committee, their election being ratified by a majority vote of the Council. Such Honorary Fellows shall be elected for life and shall pay no dues to the Association. Council may confer an Honorary Fellow with a lifetime subscription to the Association journal at the time of election.
5. **Gratis Members:** The Association Council may, by majority vote under exceptional circumstances, offer a non-dues paying Association membership and a gratis subscription to the Association journal, *Applied Geochemistry,* to an individual based upon a petition to Council and a majority vote of Council. Individuals receiving a Gratis Membership shall make the issues of the Association journal received under the Gratis Membership available to as many geoscientists as possible in his/her local area). Such Gratis Memberships and complementary journal subscriptions would have a 4-year term, but could be renewed by a subsequent petition and majority vote of Council.

II. Association Administration

A. The Association Council

1. The Council shall consist of two parts: I - seven (7) Executive Council Members (to be described henceforth as the "Executive") consisting of the Association President and Vice-President, Secretary, Treasurer, Immediate Past-President, Business Office Manager, and Journal Executive Editor; and II - ten (10) Ordinary Members (to be described henceforth as the "Council"), all of whom previously shall have been elected or appointed to their positions by the Council.
2. The Executive:
   a. The President and Vice-President shall serve a 4-year term on the basis of election by a majority vote of Council from a slate of candidates proposed by a Council-appointed Nominations Committee.
   b. The President and Vice-President are not eligible for re-election to a second term in the same position.
   c. The Immediate Past-President is an automatic member of Council, with full voting rights, for the four (4) years following his/her term of office as President.
   d. The terms of office of the President, Vice-President, and Past-President shall be synchronous.
   e. The Secretary and Treasurer are appointed by a majority vote of Council and serve a 6-year term as members of Council, with voting rights.
   f. The terms of office for the Secretary and Treasurer are to be adjusted by Council, as necessary, to prevent both from leaving office in the same year.

g. The Journal Executive Editor and Business Office Manager are appointed by a majority vote of Council and serve as Executive Members of the Council, with voting rights, as long as they occupy their positions.

3. The Council:
   a. The ten (10) Ordinary Members of Council shall be elected to serve a 4-year term on the basis of election from a slate of candidates proposed by a Council-appointed Nominations Committee, by a majority vote of Council.
   b. Ordinary Council Members shall be eligible for re-election for an additional 4-year term.
   c. No more than two (2) Ordinary Council Members should reside in and represent the same country.
   d. In the selection of candidates for Council, a good-faith effort should be made by the Nominations Committee to insure an equitable geographic distribution of Ordinary Council Members. Under normal circumstances, it is expected that there will be at least one Ordinary Council Member nominated from the Middle East and Africa, Australasia, or Central/South America during each election cycle and that no more than half of the elected Ordinary Council Members should be from North, Central, and South America.
4. The Council shall be responsible for supervising the activities, conducting the business, and achieving the objectives of the Association. A quorum for a Council meeting shall be seven (7) members of Council, which must include at least two (2) members of the Executive.
5. All members of the Council are expected to be active within the period of their appointment (i.e., participate in discussion of matters brought before Council for action, respond to messages from the Secretary and President, vote on matters put before Council for decision, etc.). Members who become inactive for a period of more than six (6) months may be removed from office by a majority vote of Council after reasonable attempts have been made by the Secretary and President to reactivate the inactive Council member.
6. Should a Council vacancy arise as the result of removal of an inactive Council member more than twelve (12) months prior to the next Association election, then an ad-hoc Committee of three (3) Council members shall be appointed by the President to fill the vacancy. This ad-hoc Committee shall bring a nomination to Council for a vote within one (1) month of the date of its appointment. The nominated candidate shall be elected to fill the remaining term of the dismissed Council member by a majority vote of Council.

B. Council Meetings and Association Business

1. A formal business meeting of Council is mandated to take place every four (4) years during the International Geological Congress.
2. During this meeting, the Nominations Committee shall formally submit for Council approval a list of recommended candidates for vacant Association Officer and Ordinary Council Member positions for the ensuing period. This slate of candidates shall be accepted by a majority vote of Council and, immediately thereafter, the new President, Vice-President, Officers, and Ordinary Council Members shall be inducted for the next four years.
3. During this meeting, the latest annual reports from the Association Working Groups shall be reviewed by Council and petitions from the Working Groups for continuation for another four (4) years considered. A decision will be made during the meeting, by a majority vote of Council, about whether or not to continue Working Groups in 'good standing'.
4. Interim Council meetings may be held at convenient times and places, as considered necessary by the Executive Committee. These meetings may be held separately or in conjunction with meetings of other scientific societies and organizations.
5. Representatives of all Working Groups and Associated Societies (see Part VI, Section E below) shall be invited by the Secretary to attend all Council meetings as non-voting guests. They shall be informed by the Secretary of the time and place of the mandated Council meeting at least sixty (60) days in advance by a special e-mail announcement and of interim Council meetings as soon after announced as is possible.
6. As far as is possible, the general business of the Association, excluding the induction of new Officers and Ordinary Council Members, shall be conducted by the Council under the direction of the President operating through the Secretary. The normal procedure for communication among Council members and for conducting Executive Committee and Council business shall be via e-mail. All interim decisions of the Executive Committee made to address emergency issues shall subsequently be ratified by a majority vote of Council within one (1) month. If not so ratified, such actions become automatically rescinded.

C. President

1. The President shall assume that office after having served as elected Vice-President, based upon endorsement by a majority vote of Council at the mandated business meeting (see Part II, Section B, Article 1 above). If the serving Vice-President is unable or unwilling to serve as President, then another member of the Executive Committee or Council shall be nominated to serve as President based upon a majority vote of Council.
2. The role of the President is to provide the leadership necessary to achieve the goals of the Association.
3. The President serves a single 4-year term and automatically becomes the Immediate Past-President when that term expires.

4. The President presides at Council meetings and works with the Secretary to develop and the business agenda for each meeting and to manage the day-to-day affairs of the Association, excluding those specific tasks assigned to the Business Office.
5. The President is designated as the official representative of the Association in dealing with other professional societies, external organizations, and the general public.
6. The President is not permitted to make official commitments and obligations on behalf of the Association without first receiving a formal endorsement through an authorization vote by a majority of Council.
7. In the event that a President resigns from office, or is unable to discharge the responsibilities and duties of the office for reasons of ill health, the serving Vice-President shall become the Interim President of the Association. If the term of service is less than three (3) years, the Interim President shall be eligible for a subsequent full 4-year term by a majority vote of Council at its next mandated business meeting (see Part II, Section B, Article 1 above).

D. Vice-President

1. The Vice-President shall be elected by Council from a list of candidates provided for its consideration by the Nominations Committee during its mandated business meeting (see Part II, Section B, Article 1 above).
2. The Vice-President serves a 4-year term and becomes the President of the Association at the end of that period, following a ratification vote by a majority of Council. If the serving Vice-President is unable or unwilling to serve as President, then another member of the Executive Committee or Council shall be nominated to serve as President based upon a majority vote of Council.
3. The Vice-President or Past-President may be appointed to be the Interim President in case the President resigns from office or is unable to discharge the responsibilities and duties of the office.

E. Treasurer

1. The Council shall appoint a Treasurer, by majority vote, and instruct the Treasurer as to the kinds of expenses for which funds may be used.
2. The Treasurer shall oversee the financial operations of the Association related to the receipt and disbursement of income as undertaken by the Business Office.
3. The Treasurer shall provide the Council with an annual financial summary that details all income and expenditures during the past twelve (12) months no later than 31 December each year.
4. The Treasurer may be re-appointed by Council for an additional 6-year term.

F. Secretary

1. The Secretary shall maintain the official records of the Association.
2. The Secretary shall be responsible for all day-to-day administrative matters associated with the operation of the Association.
3. The Secretary shall organize and conduct e-mail votes of Council as business matters arise outside the time of official business meetings.
4. The Secretary shall make all necessary preparations for Council business meetings and distribute agendas and minutes to the members of Council by e-mail at least one month prior to such meetings.
5. The Secretary shall be the point-of-contact for Members for any Association business or questions regarding the operation of the Association.
6. The Secretary shall work with the Business Office Manager and Executive Editor of the Association journal, *Applied Geochemistry*, to facilitate the recruitment of new members for the Association.
7. The Secretary shall receive proposals from Working Groups, or other organizations seeking Association sponsorship and/or financial support from the Association for a scientific activity that is compatible with the Association objectives (e.g. workshop, conference session, symposium, etc.), and shall bring such submissions to the Council for vote within one (1) month of receipt.
8. The Secretary, through consultation with Council and the Business Office Manager, shall develop a statement of 'Terms and Conditions' for any scientific activity (e.g. workshop, conference session, symposium etc.) supported by the Association. The Business Office Manager shall insure that this document is provided to the recipient of such financial support at the time it is provided and that a report the activity is obtained from the recipient within two (2) months of the event.
9. The Secretary shall invite representatives of all Working Groups and Associated Societies to attend all regular Council Meetings as non-voting guests. They shall be informed of the time and place of these meetings at least sixty (60) days in advance by a special e-mail announcement.
10. The Secretary shall provide the Council with an annual summary of all Executive Committee and Council actions and decisions during the past twelve (12) months no later than 31 January of each year.

G. Business Office Manager

1. The Council shall appoint a Business Office Manager, who shall serve a 6-year term, and be financially compensated on a semi-annual basis, at a level determined by a majority vote of Council prior to the start of the financial year and based in response to a proposal submitted at least sixty (60) days in advance by the Business Office.
2. The Business Office Manager may be re-appointed without limit by Council so long as the performance of the appointee is deemed satisfactory.

3. The Business Office Manager shall be a full voting member of Council.
4. The Business Office Manager is charged with handling the day-to-day administrative matters of the Association related to receipt and disbursement of funds for the kinds of activities that have been endorsed by Council.
5. The Business Office Manager shall submit an operating budget to Council on an annual basis. This budget shall be considered approved when ratified by a majority vote of Council. The distribution of funds to operate the Business Office shall be authorized for the Business Office Manager, in advance, by the Treasurer on a semi-annual basis.
6. The Business Office Manager shall deposit the funds of the Association in interest-bearing bank accounts and shall operate these accounts to disburse funds subject to instructions received from the Treasurer based upon decisions of Council. Only the Treasurer and the Business Office Manager shall be signatories on Association bank accounts.
7. In the event that the office of the post of Business Office Manager shall become vacant, the President may transfer the Association funds to the custody of the Treasurer until the position of Business Office Manager is again filled by Council.
8. The Business Office Manager shall provide an annual operating report to Council no later than 31 January each year that details the operating activities of the Business Office during the preceding calendar year. This report shall provide a financial summary and describe the important activities of the Business Office during the past twelve (12) months. This submission shall include the annual reports received from the Working Groups (see Part III, Section F, Article 8 below) and shall advise Council whether or not each chartered Working Group is in 'good standing,' as defined in Part III, Section F, Article 9 below.
9. The Business Office Manager shall be responsible for the semi-annual preparation and distribution of the Association Newsletter.
10. The Newsletter shall be the primary means used by the Council to communicate officially with Association Members. The newsletter shall be used to inform all Members about actions contemplated or taken by Council, contain information concerning activities of the Working Groups of the Association, and be used to communicate other matters of interest to the professional geochemical community. To the maximum extent possible, the Newsletter shall be distributed to Association Members and other recipients by e-mail.
11. The Business Office Manager is solely responsible for the accuracy and appropriateness of all items and information included in the Newsletter.
12. The Business Office Manager may accept paid advertisements in the Newsletter provided they are compatible with objectives of the Association.
13. The Business Office Manager, with the endorsement of the President, may develop and offer incentives to increase Association membership.
14. The Business Office Manager shall keep an up-to-date list that includes e-mail addresses of all dues-paid Association members and, at the request of an Officer, Council Member, or Working Group Leader, distribute Association information to the membership via the e-mail list.
15. The Business Office Manager shall insure that the organizers of all formal activities endorsed or sponsored by the Association (e.g. workshops, conference sessions, symposia, etc.), or its Working Groups, receive a sufficient number of Association information flyers and membership application forms at least one (1) month prior to the event. The Business Manager also shall insure that the statement of "Terms and Conditions' for an activity receiving financial support is provided to the organizers at the same time.
16. The Business Manager shall receive the Working Group reports, which are due from the Working Group Chairs no later than 31 December each year.
17. The Business Manager shall receive reports on activities sponsored by Working Groups, from Working Group Chairs, which are due no later than two (2) months after the event
18. The Business Office Manager shall maintain the Association web site, the content of which shall be approved by the President and Secretary, and insure that this web site is current.

H. Executive Editor of the Association Journal *Applied Geochemistry*

1. The Council shall appoint the Executive Editor of the Association journal *Applied Geochemistry* in accordance with the terms of the contract between the Association and Elsevier Science Ltd.
2. The Journal Executive Editor shall serve a 6-year term and may be re-appointed by Council to subsequent terms without limit following consultation with Elsevier and after an objective review of the Editor's job performance by the Association Publications Committee.
3. The Journal Executive Editor shall be solely responsible for the editorial policy and the content of the journal.
4. The Journal Executive Editor shall be a voting member of Council.
5. The Journal Executive Editor shall make an annual report to Council concerning the state of the Association journal no later than 31 December each year.
6. The Journal Executive Editor shall ascertain whether or not the senior author of each manuscript submitted for publication in *Applied Geochemistry* is an Association member and, assisted by the Business Office, shall provide an information sheet about the Association and a membership application form to the senior author of each paper published in the journal, if this person is not already an Association member.

III. Standing Committees and Working Groups

A. Four (4) standing committees shall exist within the Association: an Executive Committee, a Publications Committee, a Nominations Committee, and an Auditing Committee. Other committees may be created, from time to time, as deemed necessary by a majority vote Council.

B. Executive Committee

1. There shall be an Association Executive Committee, consisting of the President, Immediate Past-President, Vice-President, Secretary, Treasurer, Journal Executive Editor, and Business Office Manager.
2. The Executive Committee is empowered to take emergency action on behalf of the Council when there is not time to poll the entire Council, and to act on minor matters on which polling the entire Council is not justified.
3. Interim actions of the Executive Committee must be ratified by a vote of the full Council conducted by the Secretary within one (1) month.

C. Publications Committee

1. Council shall appoint an Ordinary Council Member to chair the Publications Committee. The Chair of the Publications Committee serves at the pleasure of Council and may continue in that capacity while an Ordinary Council Member.
2. The Chair of the Publications Committee shall select four (4) persons with experience in the publication of scientific journals and present their credentials to Council for approval. The members of the Publications Committee serve at the pleasure of its Chair and can be replaced by him/her after appropriate consultation with the Council.
3. The Chair of the Publications Committee shall make an annual report to Council concerning the status of the journal. This report, which is to be submitted to the Secretary by 31 December each year, should be sensitive to the perceptions of the authors and readers of the journal.
4. Should the Chair of the Publications Committee resign or retire, a successor shall be appointed by the Executive Committee. This appointment subsequently will be ratified by a majority vote of the full Council within one month of the appointment.
5. The duties of the Publications Committee include:
   a. Evaluating the credentials of prospective Associate Editors of the journal nominated by the Executive Editor;
   b. Assisting the Journal Executive Editor in maintaining a harmonious working relationship with Elsevier Science, Ltd.;
   c. Negotiating with Elsevier Science, Ltd. the price of the annual subscription to *Applied Geochemistry* for Members of IAGC in accordance with the provisions of the contract;
   d. Nominating candidates for the office of Journal Executive Editor, in case the term of appointment of the previous Editor has expired and will not be renewed by Council or should the previous Editor resign. The new Journal Executive Editor will be appointed by majority vote of Council after consultation with Elsevier.

D. Nominations Committee

1. The Council shall appoint an Ordinary Member of Council to be Chair of a Nominations Committee.
2. The Committee Chair shall select three (3) additional members, not more than one (1) of whom may be a Council member. The membership of the Nominations Committee shall be made known to all Individual Members through an e-mail communication from the Business Office.
3. The Committee shall formally submit for ratification by a vote of Council a list of nominations for Association Officers and Ordinary Council Members for the ensuing period. The approved list shall be made known to all Individual Members at least ninety (90) days prior to the mandated Council meeting (see Part II, Section B, Article 1 above), together with notice of said meeting.
4. Additional nominations for one or more Officers and Ordinary Council Members may be made in writing to the Secretary by fifteen (15) or more Individual Members of the Association not less than sixty (60) days prior to the mandated Council meeting (see Part II, Section B, Article 1 above).
5. Election of Association Officers and Councilors, based upon the slate of candidates put forward by the Chair of the Nominations Committee at the mandated Council meeting shall be by majority vote of Council.
6. The Nominations Committee shall remain active until the term of its Chair expires.

E. Auditing Committee

1. The Council shall appoint the Chair of an Auditing Committee to verify the accuracy of the annual financial report of the Treasurer in advance of its presentation to Council.
2. The Committee Chair shall select two (2) members of Council to serve on this committee and inform the Secretary of the Committee membership, which will be endorsed by a majority vote of Council.
3. The Committee will remain active for a 4-year term or until either its Chair resigns or Council decides to appoint a new Chair.

F. Working Groups

1. The Council may, by a majority vote, charter specialist Working Groups, from time to time, as deemed to be helpful in meeting the objectives of the Association.
2. The charter of a Working Group shall run for no more than four (4) years, from the time of initial charter until the next mandated Council meeting (see Part II, Section B, Article 1 above).
3. The Council will formally appoint the Leaders of all Working Groups. Existing appointments will remain effective until such time as a new appointment is made or the term of the Working Group expires.
4. The Council may establish new Working Groups, as well as discontinue or change the leadership of existing Working Groups.
5. Working Groups may establish an internal administrative structure and process to conduct the business of the Working Group.
6. In the case of well-organized Working Groups operating under their own statutes, Council will recognize the need of these groups for autonomy and, in normal circumstances, the appointment of a Working Group Leader will be consistent with the recommendations of the Working Group.
7. A Working Group organizing and/or sponsoring an activity endorsed or financially-supported by the Association (e.g. workshop, conference session, symposium, etc.) shall insure that the Association affiliation is presented on all official documents and that Association information flyers and membership application forms, to be provided by the Business Office, are made available to the participants. A report on such activities will be provided to the Business Office no later than two (2) months after the event.
8. Each Working Group shall submit an annual report to the Business Office no later than 31 December each year. The annual report shall be reviewed and endorsed by Council and then published in the next Association Newsletter.
9. A Working Group is considered to be in 'good standing' when it has been active during the preceding year, its annual report has been submitted on time, and it has fulfilled its obligations to the Association for any activities the Association endorsed or sponsored during the past year. The determination of 'good standing' for a Working Group shall be made by the President through a recommendation to Council, based upon the information provided by the Business Office at the end of January each year.
10. All Working Groups in 'good standing' that wish to continue may be re-chartered for an additional 4-year terms by a majority vote of Council during the mandated Council meeting, so long as the performance of the Working Group and its appointed leader(s) are deemed satisfactory. There is no limit to the number of times that a Working Group may be rechartered.

IV. Scientific Activities

1. Sponsorship of Scientific Activities
   a. The Association may sponsor, support, or conduct scientific activities compatible with its objectives through endorsement by a two-thirds majority vote of Council.
   b. Working Groups, or other organization seeking Association sponsorship and/or financial support for a scientific activity that is compatible with the objectives of the Association (e.g. workshop, conference session, symposium, etc.), shall submit a formal proposal to the Secretary no later than ninety (90) days prior to the event. The Secretary will bring such submissions to the Council for vote within one (1) month of receipt. The Business Office shall then in a timely manner act to provide the support to all activities endorsed by Council.
   c. Once Council approval has been received for a sponsored activity, the Business Office Manager, shall provide the statement of 'Terms and Conditions' developed for the scientific activity (e.g. workshop, conference session, symposium etc.) supported by the Association to the organizers at the time that the financial support is provided. Association information flyers and membership application forms shall be provided by the Business Office to the organizers of all Association endorsed and sponsored activities for distribution to the participants during the event. The Business Office Manager shall insure that a recipient of Association sponsorship or financial support provides a report on the activity within two (2) months after the event.
   d. Any activity or organization receiving Association financial support shall insure that this sponsorship is acknowledged on all official documents and that Association information flyers and membership application forms, provided from the Association Business Office, are made available to the activity participants. The Association, through the decision of the Executive Editor of the Association journal Applied Geochemistry, shall have first right of refusal for publication of special proceedings volumes arising from any conference or symposium financially supported by the Association.
2. Ingerson International Lecture
   a. The International Ingerson Lecture of the IAGC is based on a bequest by Dr. Earl Ingerson, first President of the Association. The funds are invested separately by the Business Office and only the accrued interest is used to support the Lecture, supplemented by general funds as required.
   b. The Lecture is scheduled every two (2) years at a suitable scientific meeting organized by a Working Group of the Association or by another scientific society.
   c. The Lecturer is selected by the Executive Committee based on a nomination by any member of Council.

d. The Lecturer must be an outstanding senior geochemist who resides in the geographic region in which the lecture is to be given.
e. The topic of the Lecture is to be chosen by the Lecturer and may consist of a synthesis of known facts, or of new data, or a combination of both.
f. The Lecture is to be introduced by the President of the IAGC, another member of the Executive Committee, or the Leader of the Working Group sponsoring the meeting.
g. The Lecturer receives an Honorarium of $500 US and a framed certificate that shall be presented during the introduction of the Lecturer.
h. The Secretary shall maintain the list of names of the past Lecturers, who shall be identified in program notes to be distributed to the audience at the Lecture, and the Secretary shall prepare a short article on the Lecturer for the Association Newsletter.

V. Finances

A. Dues and Contributions

1. Annual dues for all classes of Association Members shall be established by Council upon a recommendation from the Executive Committee that is endorsed by a majority vote of Council.
2. No dues are required of Associated Societies (see Part VI, Section E below).
3. Sustaining Members will be designated based upon annual contributions to the Association substantially larger than the annual dues they would pay as individual Members. Sustaining Members will be acknowledged annually in the Newsletter.

VI. General

A. Affiliations

1. The Association may affiliate with appropriate international unions and other organizations with geochemical interests in order to further the objectives of the Association. Any affiliation must be approved by a majority vote of Council.

B. Amendments to the Existing Statutes

1. The Council shall have the power to modify its Statutes by majority vote.
2. Requests for changes of the existing Statutes may be submitted at any time either by a member of Council or by a group of at least 20 Individual Members. The decision of Council regarding any changes to these Statutes will be communicated to the Association membership through an e-mail message and also published in the next issue of the Newsletter.

C. Official Languages

1. The official language of the Association shall be English, although Association business may be conducted in another major scientific language such as French, German, Spanish, or Russian should it be convenient to do so.
2. English text shall be considered authoritative in the interpretation of these Statutes.
3. The Association Newsletter, Working Group reports, and other annual reports shall be presented and distributed in English.

D. Petitions to Council

1. Any group of at least 20 Individual Members can bring a matter to Council for consideration through a signed petition. . The decision of Council regarding such petitions will be communicated to the Association membership through an e-mail message and also published in the next issue of the Newsletter.

E. Associated Societies

1. Any international, regional, or national scientific society, with a particular interest in the objectives of the Association that wishes to join with the Association in seeking to achieve those objectives, may become an Associated Society.
2. This association can be established by mutual agreement between Council and the official representatives of the Associated Society.
3. No hierarchical relationship between the Association and the Associated Society is implied by joining in this way.
4. Associated Societies will receive all Association general mailings and will be notified in advance of all Council meetings.
5. The Association Newsletter shall be provided to the Associated Society Secretary or other designated recipient of the material by the Business Office through e-mail.
6. Associated Societies are expected to maintain effective contact with the Association and provides up-to-date mailing addresses to the Secretary.