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RECENT ACCOMPLISHMENT IN GEOLOGY

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Your Imperial Highness the Crown Prince Naruhito, Distinguished Authorities, colleagues, delegates, ladies and gentleman.

It is a great pleasure for me to have this opportunity of addressing you again on the opening ceremony of the International Geological Congress, this time in hospitable Japan, and in Kyoto, with its venerated position in Japanese history, a spectacular scenic landscape, and a highly motivating geologic context.

We meet at a very important turning point of history of mankind; a time in which we are redefining the directions of further human development. The Rio-92 Conference on Environment and Development of the United Nations has just finished, and the major problems which are threatening society, now and for the future, have been clearly identified. About a hundred thousand generations of Homo Sapiens were needed to reach the present world population of five billion people. And yet, this number will double in the next few decades. Our planet is becoming smaller and smaller, some non-renewable resources are nearing exhaustion, the environment has been increasingly damaged and spoiled, and we are still very far from the idealized situation of sustainable development, on equitable basis for all of humanity.

Science and technology are accused of bringing about many of these problems confronting the world today. This is not correct! The problems arise from the manner the advances in knowledge have been used by people, companies, institutions, countries, moved by ignorance and self interest and consequently employing pragmatic but predatory cost-benefit equations in their plans, not taking into account the environmental situation, and neglecting the long-term damaging effects of their actions.

Our hopes for a satisfactory common future are indeed based on further advances of science and technology, to open new pathways of development. These will call for reduction and optimization of resources use, recycling of industrial wastes, employment of regenerative agriculture, social forestry, and other environmentally sound and sustainable mechanisms. You see that Science has a great responsibility towards humanity, and the difficulties are of global nature, which necessarily calls for international and interdisciplinary efforts. The geosciences have a fundamental role to play, in addressing those global problems, and we geologists are fully prepared, in fact anxious to play our part.

Geology is alive and well, and has been very active over the past few years. As you know, at the opening ceremonies of the International Geological Congresses, over the past few years traditionally the outgoing President of the International Union of Geological Sciences has to summarize the major accomplishments that have occurred over the past term. Since time is very short, I will concentrate only in a few examples, which I consider the main highlights. They are all associated with relevant technological developments, which have considerably enhanced our capacity to observe the Earth, and to measure with increased precision the manifestations of its internal dynamics, and its surface processes.

Let me start with the progress made in the field of Mineral Deposits and Metallogenesis with the evidence from sea floor observation, on submarine hot springs, continuing to show the remarkable hydrothermal discharge that forms metalliferous deposits in many of the world's oceans. In recent years, several were discovered, not only associated with mid-ocean ridge systems, but from a variety of different tectonic settings, including subduction plate margins. Studies of these modern deposits have shed much light on the formation of the ancient ones.

Great advances have been made in the observation and interpretation of past climates. From deep sea sediments, Vostok ice cores, lacustrine materials, and so on, we can reconstitute the pattern of past ocean circulations, the past records of C02 abundance in the atmosphere, past surface temperatures, past records of solar radiation, precise regional sea level variations, and other parameters. We can say now that the Earth's internal dynamics plays a big part in the global climatic changes. Milan Kovitch alone doesn't work

In Geodynamics, geologists, geochemists, and geophysicists working together have made improved interpretations of the deep Earth with the aid of numeric simulations using super computers. The conclusion is that probably the entire mantle of the Earth is, and has been, more dynamic than previously thought. Although still speculative, the notion of "mega-plumes" is beginning to attract attention, and the importance of crust-mantle mixing in subduction zones has been demonstrated. Moreover, in the context of crustal evolution, the concept of the agglutination and subsequent fragmentation of a few supercontinents during the Earth's history has been gaining strength.

Improvements in mass spectrometric measurements made possible the application of the Re-Os method to geological materials. The method has turned out to be an impressive tool to investigate old cratonic areas, as a tracer for recycling of crustal material. In the history of the Earth in the early Archean, the isotopes indicate a strong early mantle depletion, implying massive crust formation, however we have up to the moment no indication of a correspondent primitive crust enriched in incompatible elements. Zircon geochronology has further developed in recent years, with improvements in the methodologies and in the interpretation techniques. A few months ago the oldest known zircon of the solar system was dated by the SHRIMP ion probe technique, a small crystal within the Vaca Muerta achondrite, which confirmed the 4.56 Ga already obtained by other methods for this very primordial event in the evolution of the meteorite parent bodies.

Spectacular advances in comparative planetology have been achieved with the great success of the Magellan mission, uncovering Venus, and revealing to us many of its mysteries. Our sister planet has an extremely complex surface, with widespread evidence for volcanism, as well as for horizontal extension and compression. Tectonic features include mountain belts, ridge belts, large rifts, fracture systems, and trenches, however, there is no clear evidence for Earth-style plate tectonics, in which the geodynamics features are concentrated in plate boundaries. Several hundred impact craters have been identified on Venus, and its average surface age is of about 500 million years.

Talking about impact cratering, a structure was identified as the possible site of a large bolide striking the Earth at the K/T boundary. It is the buried Chicxulub structure in the Yucatan Peninsula, Mexico, which has recently presented definitive evidence of its impact origin. Moreover, the target rocks include anhydrite, which could have released billion of tons of sulfur dioxide into the atmosphere, with devastating global effects which could easily explain the observed mass extinctions at the K/T boundary.

In most sub-fields of the geosciences, technological developments have been continuous. The use of computers is world wide, GIS systems are largely used by the main mining companies and geological surveys. Geoscience information is being processed and

disseminated at ever greater speed. The oil companies increasingly make use of mathematical simulations to study the physical-chemical processes involved in the formation of sedimentary basins, their tectonic evolution, and the origin of their hydrocarbons. Geostatistics are also increasingly applied to reservoirs and their influence on fluid displacements, and to resource assessment.

Development of instrumentation in certain fields has been critical as in experimental petrology, where major advances have been produced here in Japan, especially in the field of high pressure instrumentation. In the monitoring of seismic events, I wish to mention the high quality broad band seismometers developed by our Californian colleagues, which I visited a few days ago, and constitute the TERRA scope Network. This equipment is able to obtain instant data, in real time, of seismic parameters, including rupture propagation, speed and direction, enabling seismologists to provide timely information about significant earthquakes. And while I am dealing with earthquakes, let me mention the surprisingly accurate results obtained by our Greek colleagues in earthquake prediction by the VAN method, based on geoelectric potential monitoring, and although there is no satisfactory theoretical explanation for it, it certainly deserves more attention.

These few examples, as well as many others which I could have brought here, demonstrate that our capacity to observe the Earth, to study it, and to understand its dynamics has improved greatly in recent times. We geologists understand that we have to deal with a very large global science, which concerns the whole Earth System, and that all of our specialties in the solid-earth sciences, as well as all the others in the atmospheric and oceanographic sciences, are only pieces which have to be integrated in a complex interdisciplinary way.

During my opening remarks at the Washington Congress, three years ago, I urged the geological community to interact with our counterparts in the other sciences, and to contribute to solve the many common problems related to the environment. I think I can see a clear trend in this direction, because most geological surveys in many countries already adapted themselves to a shift into environmental issues, following the interests of their own governments. In addition, the undergraduate bodies in Geology, all over the world, include students increasingly interested in environmentally related subjects.

IUGS itself also followed the mentioned trend, through a direct participation in the Global Change program of ICSU, its strong involvement in the Decade of Natural Disaster Reduction of the United Nations, and through the creation of a special commission dealing with Geology for Environmental Planning and Management, the COGEOENVIRONMENT. This commission has been very active in promoting effective links with policy-makers, and trying to increase awareness among the general public and decision-makers about the importance of earth science for efficient management and protection of the environment and its resources.

Now, are there sufficient reasons to hope that sustainable development can be attained in a few decades? Yes, I am sure. I was in Rio for a few days during the UNCED-92, and I felt the very special atmosphere of global consensus and confidence in a better future. Environment and development issues were made openly accessible to the public all over the world. Politicians and government executives of all countries are presently well aware of the problems which threaten the future of mankind, and despite the great difficulties involved in the proposed resolutions, there is no going back!

In the cooperative efforts with our colleagues of other branches of science, engineers, planners, policy makers, we geologists have the advantage of being familiar with observation and monitoring of the Earth processes, as well as map construction and interpretation. We will always play a prominent role when dealing with exploitation and management of mineral resources, ground water reservoirs, and non-renewable sources of energy. We will also be of great value for comprehensive studies of soil degradation and erosion, prevention and mitigation of natural disasters, and different types of research involving geotechnical and geoengineering aspects.

But the Rio Conference is only a starting point, and the pathway is full of great difficulties presented by the various self-interests at any level - individual, local, regional, national, and supranational - which characterize human nature. More than ever we need social solidarity, among all of us, we peoples of different origins and different races.

Are we on the way to a better world?

At present the distances which separate the rich and the poor are still increasing, but there is hope that this tendency will reverse at the beginning of next century. Probably the present generation will not see a world with social equality, in which all basic needs will be satisfied. But why not to believe that our children or grandchildren could one day benefit from the successful results of the actions which we are now starting, for our common future?

To conclude, science and scientists have a great responsibility to bring about sustainable development, and geologists have to play a prominent role. It is our responsibility to instruct politicians, educators, and the general public on the issues related to the earth processes. In doing so, perhaps Geology will leave its present semi-isolation, and will acquire a new human dimension.

(Speech in the Opening Ceremony)

PROGRAM CHANGES

Cancellation

I-1-2 O	8, 9
I-3-27 O	1, 3, 6
I-3-27 P	1, 2
I-3-30 P	2, 5, 10, 11, 12, 14
I-3-33 O	7
I-3-33 P	4
I-3-46 O	1
I-3-46 P	3, 5, 6
II-1-8 P	12, 24, 25, 28
II-11-1 O	6
II-12-6 P	7
II-14-4 O	1, 2
II-16-1 P	4, 9, 11
II-2-8 P	23
II-3-2 P	12, 15, 16
II-4-4 O	1,3, 6, 7, 8
II-4-4 P	1
II-5-3 O	6
II-5-3 P	4, 7, 10, 20, 21, 24, 27, 28, 29, 30
II-6-5 O	4, 9, 12
II-6-5 P	2, 7, 11, 20
II-6-10 P	13, 27
II-7-1 P	2, 14
II-7-4 O	2
II-7-7 P	20
II-8-3 O	18, 19
II-8-3 P	7, 14, 62
II-8-6 O	3
II-8-6 P	4, 9, 16, 18, 21, 30, 31, 32, 34
II-9-1 O	3, 8, 9, 10, 16, 20
II-9-1 P	9

Shift and New Entry

from	to	from	to
new entry	I-3-26 P	II-2-8 P 6	II-2-8 O 08
new entry	I-3-26 P	II-3-2 P 8	II-3-2 O 16
new entry	I-3-29 O 10	II-4-4 P 7	II-4-4 O 04
new entry	II-10-1 P 4	II-4-4 P 8	II-4-4 O 05
new entry	II-12-6 P	II-6-2 O 1	II-6-2 P 22
new entry	II-14-4 O 04	II-6-2 O 16	II-6-2 P49
new entry	II-8-3 O 16	II-6-2 P49	II-6-2 O16
new entry	II-9-1 O 03	II-6-5 P 5	II-9-1 O 09
I-3-27 P 3	I-3-27 O 06	II-6-5 P 9	II-6-5 O 13
I-3-27 P 4	I-3-27 O 07	II-6-5 P 26	II-6-5 O 11
I-3-27 P 5	I-3-27 O 08	II-6-5 P 27	II-6-5 O 14
I-3-33 P 1	I-3-33 O 07	II-7-4 P 3	II-7-4 O 08
I-3-37 O 1	A2 O 08	II-8-3 P 20	II-8-3 O 07
I-3-46 P 8	I-3-46 O 01	II-8-3 P 31	II-8-3 O 17
II-2-8 P 3	II-2-8 O 11	II-8-3 P 48	II-8-3 O 19