Historical Aspects of the IGY

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Editor's Note: During the week of September 25–October 3, 1982, an exhibition was organized at the Academy Palace in Brussels as Belgium's celebration of the 100th anniversary of the First Polar Year, the 50th anniversary of the Second Polar Year, and the 25th anniversary of the International Geophysical Year. It was dedicated to past and present geophysical activities in order to show the promises of future work. Five organizations took part in the exhibition: the Aeronomy Institute, the Antarctic Research Committee, the National Geographic Institute, the Meteorological Institute, and the Royal Observatory. King Baudouin gave his sponsorship and visited the exhibition.

The following article is based on a speech delivered by Marcel Nicolet at the inauguration ceremony on September 25. The speech, entitled 'Les tenants et les aboutissants de l'Année Géophysique Internationale,' was translated by C. M. Minnis, URSI Secretary General Emeritus.

Geophysics is a branch of science which has successfully integrated many different areas of research into a coherent whole. It represents the synthesis of various broad fields of knowledge relating to both the past and the present, and this provides a basis for speculating about the future. Since geophysical research must be pursued over the whole of our planet, into the most distant continents, and even across Antarctica, it calls for the application of all man's resources. It reconstructs the past through a process of reappraisal, reflection, and discussion; it elucidates the present and thereby leads us not only to image, to measure, and to study distant events, but also to understand better the mysteries of nature. Indeed, knowledge is the key which geophysics uses to open doors leading toward the future. Geophysics must also be accepted as a branch of fundamental research in which concerted action is an essential feature; it remains in contact with society by combining research and development and assesses the value of the knowledge acquired in terms of the contribution it makes to the welfare of mankind.

In the history of science, the First International Polar Year (1882–1883) was the first major event in which the fundamental concept was multidisciplinary cooperation on an international scale. Weyprecht, who conceived the idea of such a project, was obliged over a period of several years to defend his proposals and to promote them. It was not until a year after his death, and in spite of the outbreak of the war in the Balkans, that a small group of geophysicists of the period launched this first great peaceful enterprise.

In the wake of the heroic epoch of the First Polar Year, there followed many important developments in scientific instrumentation, and great improvements in communications within and between the continents. It was in 1927 that J. Giorgi, a meteorologist, made the suggestion that the 50th anniversary of the First Polar Year should be celebrated in 1932. This led to the creation of a Special Commission which was made responsible for the Second Polar Year (1932–1933); its President was D. laCour, Director of the Meteorological Service in Denmark. The preparations for the event were confronted with many difficulties arising out of the world economic crisis of the 1930s; indeed on several occasions doubts were expressed about whether it was wise to continue, but finally these were overcome by the tenacity and the persuasive powers of laCour.

In the end, in spite of the practical problems encountered, the program for the Second Polar Year was carried out. Unfortunately, the outbreak of World War II in 1939 resulted in the suspension of normal international scientific relations. After the end of the war, in 1946, the Conference of Directors of the International Meteorological Organization, at its meeting in London, decided to dissolve all its Commissions. However, at its meeting in Paris in July 1946, the International Meteorological Committee created the Polar Year Liquidating Commission; this body was made responsible for continuing the analysis of the data, which had already begun before the War, and for completing the task by December 1950.

In this connection it is important to recall that the President of the Liquidating Commission was John Fleming, President of the International Association of Terrestrial Magnetism and Electricity from 1934 to 1948, and also Director of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington. Thanks to his worldwide reputation, Fleming was able to stimulate geophysicists into thinking about what future actions should be taken so as to give a fresh impetus to their branch of science. The range of new techniques already available, including the first rockets carrying scientific instruments, led them to give high priority to making observations in the third dimension. The need to think in terms of a new commitment of some kind was further strengthened by the approaching target date for the completion of the study of the data acquired during the Second Polar Year: December 1950.

It was in this atmosphere that, in January 1950, I visited the Department of Terrestrial Magnetism and the National Bureau of Standards in Washington, D.C. before spending 6 months in California. Just afterward, in fact on April 5, 1950, Lloyd Berkner made the first suggestion about the possibility of organizing a series of polar years separated by intervals of 25 years. At a meeting of about 20 scientists (Bates, Berkner, Chapman, Elvey, Kaplan, Nicolet, Roach, Tuve, Van Allen, . . .) in May 1950, held at Inyokern, China Lake, in the California desert, there was some discussion about various aspects of research in the upper atmosphere, during which ideas put forward by several participants were borne in mind.

These ideas were raised again in July 1950 at a meeting of about 200 scientists who participated in a 'Conference on the Physics of the Ionosphere,' convened by A. H. Waynick of the Ionosphere Research Laboratory of Pennsylvania State University. On this occasion, some of those ready to go to Brussels were in favor of officially submitting the idea of a new 'international polar year' to the Mixed Commission on the Ionosphere, which was due to meet in this 'Palace of the Academies' September 4–6, 1950. Thus Brussels became the focal point, 25 years ago, for the project which came to be known as the International Geophysical Year, 1957–1958.

The Mixed Commission (E. V. (later Sir Edward) Appleton as Chairman and a membership of Aono, Berkner, Beynon, Booker, Burrows, Maeda, Hagihara, Hamada, Herbays, Kotani, Lejay, Martyn, Massey, Menzel, Nicolet, Shapley, and Waynick) forwarded its proposals to the scientific unions represented in it. These were approved by all the unions, including the IUGG, which held its General Assembly in Brussels in 1951 at the invitation of the Belgian National Committee for Geodesy and Geophysics. In May 1952 the International Council of Scientific Unions (ICSU) formed the Special Committee for the International Geophysical Year, usually known under the initials of its French title: CSAGI. The members designated to represent the unions were: Berkner and Beynon (URSI), Coulomb and Laursen (IUGG), Norlund and Nicolet (IAU), and Wordie (IGU). Van Mieghem was later enlisted to represent the World Meteorological Organization.

The first official meeting of CSAGI was attended by the three senior representatives, Berkner, Coulomb, and Nicolet, and took place in Brussels on October 13, 1952. Through our Secretary, E. Herbays, we appealed to the national academies of sciences adhering to ICSU, as well as to the interested unions and the World Meteorological Organization (WMO), for their collaboration. At the same time, a request for financial support was made to the United Nations Educational, Scientific, and Cultural Organization (UNESCO).

The CSAGI met in this Palace from June 30 to July 3, 1953, at the invitation of our Academies, and by this time 30 national academies had already agreed to support the concept of the International Geophysical Year. Before the IGY began, general assemblies were convened in 1954, 1955, and 1956 in Rome, Brussels, and Barcelona respectively;

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the final Assembly was held in Moscow in July 1958.

The membership of CSAGI was made up of the representatives of the scientific unions, with the participation of the WMO. From its inception, the Committee had the responsibility for developing a practicable program of observations covering the various disciplines of geophysics. The diversity of the topics incorporated in the final program soon resulted in the inclusion of about 30 members in the Committee.

Accommodation for the General Secretariat of CSAGI was provided at Uccle, near Brussels, by the Radiation Service of the Royal Meteorological Institute in Belgium. The central direction of the program was entrusted to a bureau, whose members were: S. Chapman, President (U.K.); L. Berkner, Vice-President (U.S.); M. Nicolet, Secretary General (Belgium); J. Coulomb, Member (France); and V. Beloussov, Member (USSR).

In addition to the bureau, there were 14 discipline reporters, each of whom was responsible for one of the scientific disciplines. They are listed in Table 1, and their names and interests give some idea of the scope of the program as a whole. Finally, the CSAGI included several assistant scientific secretaries who were given the task of organizing a number of international conferences, each designed to deal with questions of particular interest to a geographical region.

For each of the disciplines, the program was first elaborated by a committee created under the auspices of one or more of the unions and scientific associations adhering to ICSU. After this preliminary stage, the IGY program as a whole was studied by the bureau and by CSAGI, and was finally coordinated during the general assemblies, at which all the participating academies were represented, and also during the regional conferences mentioned earlier. Other conferences were held to discuss questions concerning related groups of disciplines. One of these, held in Washington, D. C. from September 30 to October 5, 1957, dealt with the problems of rockets and satellites and coincided with the launch of Sputnik 1, the first artificial earth satellite, on October 4.

It would not be possible here to review all the preparatory work carried out within each discipline. Briefly, each Reporter carried the responsibility for editing an Instruction Manual containing sections prepared by experts. About a dozen of these manuals were distributed to the IGY participating committees before the beginning of the observational program, and were published in *Annals of the IGY*. In addition, each of the unions interested in the IGY had already sent out information on the essential elements of the programs with which it was concerned.

Because of limitations on the number of scientists and on the availability of equipment, not to speak of financial restrictions, attention was concentrated on three geographical areas: the Arctic, the Antarctic, and the equatorial belt. These satisfied certain geographic and geomagnetic conditions determined by the requirements of the various disciplines, and took account of the logistical facilities then available. In addition, three other zones were superimposed on those just mentioned; these were defined in terms of geographical meridians and corresponded to the continent of North America, Europe, Africa, and the Far East (or 140°E). Thanks to the decision to concentrate attention on certain geographical regions, it was possible to economize when deciding on the locations of new stations, while at the same time facilitating the acquisition of representative data for most geophysical phenomena.

Some idea of the vast scale of the preparations for the IGY can be gained from the fact that the first 10 volumes of *Annals of the IGY*, which were devoted to this aspect of the program, contain 5,000 pages.

It is worth recalling that, as early as 1953, the IGY Bureau had foreseen the possibility of launching artificial satellites in 1957 or 1958 during the IGY. Indeed, this was borne in mind when the IGY symbol was designed by the IGY Secretariat in 1954; it showed the trajectory of a satellite across a background of lines of latitude and longitude as well as the boundary between night and day, and it emphasized the privileged place given to th Antarctic.

Here today, in the marble hall of this Palace, you will find the exhibition commemorating the 25th Anniversary of the IGY. It was in that same hall, at 6:45 P.M. on July 29, 1955, that the first announcement was made of the future launch of an artificial satellite. As Secretary General of CSAGI, I had that morning received, by special messenger, a letter from the President of the U.S. National IGY Committee. The news of the coming event was publicly announced in Brussels at the local time corresponding to the time of the official announcement made simultaneously in Washington, D. C. and in 40 countries participating in the IGY.

At the beginning of 1956 I invited the IGY Committee in the USSR to consider participating in the program involving rockets and satellites. The invitation received an immediate welcome, but the official announcement of the plans envisaged was not made until the General Assembly of CSAGI in Barcelona in September 1956.

The first use of artificial satellites for scientific research during the IGY was in itself an outstanding event, but it marked also the beginning of an intensive exploration of the terrestrial environment in space, which has since led to the even more remarkable achievements of the present time. The explosion which took place 25 years ago in studies of aeronomy in association with terrestrial magnetism resulted in a profound modification of the basic ideas that had formerly been accepted in investigations of the relations between solar and terrestrial phenomena.

The subject of terrestrial magnetism quickly divided into two different aspects, each corresponding to particular types of experimental and theoretical investigations. The first of these is internal magnetism, which relates to the physics of the earth's interior, while the second, external magnetism, refers to the extremely complex variations caused by changes in the geometry of the lines of magnetic force; these can occur at distances ranging from 10 earth radii down to an altitude of 1000 km. It is for this reason that certain characteristics of the ionosphere and also the modulation of extra-galactic cosmic rays are both closely connected with the variations in the magnetic field that take place at the outer limits of the atmosphere. The simultaneous study of such phenomena during the IGY led naturally to a logical rearrangement of the disciplines, which recognizes the morphological coherence of the various elements now included in 'external geophysics.'

The successful planning and preparation of such a complex operation as the IGY was greatly facilitated by the great flexibility of the organizational structures adopted, and also by the cooperation of the most distinguished representatives of the international scientific unions. In addition, a grant of $100,000 made by UNESCO and the contributions ($200,000) received from the participating committees made it possible to maintain a permanent Secretariat at Uccle during the 6-year period from 1953 to 1959. This Secretariat, without which I could not have fulfilled my responsibilities, consisted at first of Phillip Mange and Delphine Jehoulet, now in the United States; they were joined later by Paulette Doyen, Mike Baker, and Francine and Maurice Hautfenne, who are present today. Sir Archibald Day (Coordinator) and Sir Harold Spencer Jones (Editor of the *Annals of the IGY*) both died several years ago.

As for the results achieved during the IGY, it would be quite impossible to review them here since their description takes up 38 volumes of the *Annals*. The completion of this series of 45 volumes was made possible by the creation of the International Geophysical Committee (CIG) after the dissolution of CSAGI in 1959. This Committee also laid the foundations for a new program of observation: the International Years of the Quiet Sun (IQSY), 1964–1965.

Before concluding, I must refer to the way

TABLE 1. The Discipline Reporters of CSAGI

Activity	Reporters
World Days	A. H. Shapley (U.S.)
Meteorology	J. Van Mieghem (Belgium)
Geomagnetism	V. Laursen (Denmark)
Aurora and Airglow	S. Chapman (U.K.) (with F. Roach and C. Elvey, both U.S.)
Ionosphere	W. J. G. Beynon (U.K.)
Solar Activity	Y. Ohman (Sweden)
Cosmic Rays	J. A. Simpson (U.S.)
Longitudes and Latitudes	A. Danjon (France)
Glaciology	J. M. Wordie (U.K.)
Oceanography	G. Laclavère (France)
Rockets and Satellites	L. V. Berkner (U.S.)
Seismology	V. V. Beloussov (USSR)
Gravimetry	P. Lejay (France)
Nuclear Radiation	M. Nicolet (Belgium)

in which a voluntary organization including representatives of 67 countries succeeded in steering such a complex project to a successful conclusion.

The first important achievement of the IGY was that it attracted the attention of thousands of men and women from all parts of the world who freely and spontaneously devoted their efforts to the attainment of a common scientific objective.

Besides this, the enterprise was able to benefit from the support of governments without itself being a governmental body; in addition it could count on logistical support provided by armed forces without being in any way military in character. Finally, although the IGY was based on international collaboration between scientists in 67 countries, it was able to avoid becoming involved with the rigid framework of established international organizations.

The IGY successfully attained its main objectives, but it would be wrong to conclude that the political conditions of the period were always favorable. I shall not refer here to various events, relating to the international political situation, which often complicated the task of those who were engaged in the direction of the enterprise; these might, perhaps, be a subject for another occasion. Today, I shall simply say that the geophysicists kept their feet on the ground and, although they were sometimes obliged to express disapproval, they never gave way. They kept their eyes firmly fixed on the ultimate objectives, and their will to attain these was sufficiently strong to enable them to surmount the natural and the artificial barriers that they encountered.

In the final analysis, the IGY can be regarded as a crucible out of which the science of geophysics emerged with new, permanent characteristics. It served to define certain new guidelines, and these have since determined the directions in which modern geophysical research is now progressing. Today, this research is carried out in an atmosphere of international collaboration, the origins of which are unknown to the present generation. Every true geophysicist accepts this collaboration without hesitation and in a spirit of scientific rivalry in the service of mankind.

Krakatau 1883: A Classic Geophysical Event

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This week marks the 100th anniversary of Krakatau's 1883 eruption, perhaps the most famous volcanic event in recorded history. During a 23-hour period on August 26 and 27, 1883, more than 18 km^3 of volcanic debris thundered upward from Krakatau, resulting in the death of more than 36,000 people and causing widespread devastation to the surrounding area. Moreover, the 1883 events at Krakatau caused geophysical phenomena that were observed around the world, making it (at least up until Mount St. Helens' 1980 eruption) the household word for a classic volcanic catastrophe.

One hundred years ago, Krakatau was a 5 × 9 km island in the Sunda Straits, between Java and Sumatra in the Dutch East Indies. It was a familiar landmark, both to the tens of thousands of nearby coastal residents and to the crews of thousands of ships from Europe and the Americas that passed through the Straits each year on their way to and from the far east. The volcano had last erupted in 1681 and was not regarded as a likely site for renewed and catastrophic activity.

Several large earthquakes were felt in the Sunda Straits area in the early 1880's. More occurred on May 9 and 10, 1883, initiating a 5-day swarm of felt earthquakes that led directly to the outbreak of the initial activity on May 20, when ash and steam boiled upward from the volcano, producing a spectacular sight. One hundred years ago, before the advent of telephones and television, people paid more attention to the written word, and many recorded their observations in marvelously expressive prose that somehow makes the event come alive again. For example, the chaplain of the German warship *Elisabeth* described the initial eruption as follows (translation from the German by H.-U. Schmincke):

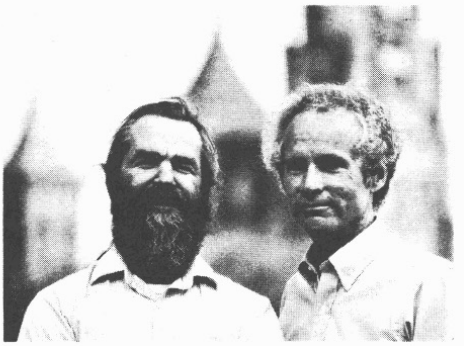
> There, at least 17 nautical miles distant, an enormous, shining, wide, vapor column rose extremely rapidly to half the horizon, and reached within a very short time the colossal height of at least 11,000 meters . . . the sky darkened continuously until a homogeneous, gray cloud covered the entire horizon. We should not remain in doubt for long about the nature of these clouds. The fresh wind came from the sea and not from land, and brought along very fine ash rain, which laid a light-gray, slightly yellowish, extremely fine, pulverized mass on the entire ship. . . . On the next morning, May 21, the ship, which was so clean 24 hours ago, looked very strange: It looked like a mill ship or, more precisely, like a floating cement factory.

On May 27, the steamship *Loudon* visited Krakatau to obtain a closeup view of the ongoing eruption, and amongst its fascinated passengers was a photographer named Hamburg. He apparently took several photographs of the scene, because in succeeding years a number of published accounts of the Krakatau eruption (including the famous 1888 report by the Royal Society of London) contained lithographs and other artistic renditions that were said to have been derived "from a photograph taken on Sunday, May 27, 1883."

To our knowledge, the most famous of these photographs remained lost and was never published—that is, until a Smithsonian colleague surprisingly discovered that the grandson of R. Bréon (leader of the French expedition to Krakatau in 1884) currently lives in Paris and that, safeguarded in his family album, were the missing Hamburg photographs of the erupting volcano. One of these photographs is reproduced on the cover of this issue of *Eos*.

After the *Loudon*'s visit on May 27, interest in the eruption seemed to wane. The eruption in fact continued with considerable vigor, but few details were recorded, and it is said that visitors to Batavia (now Djakarta) might have failed to hear of its existence at all. The last person to set foot on the island was a topographic engineer named Ferzenaar. He carried out a partial survey of the island in early August 1883 (Figure 1) but, noting the continuing activity, counseled that a more complete "survey of the island itself is inadvisable."

Two weeks later, on August 26, the paroxysmal eruption began and continued with extraordinary intensity until about noon on August 27. The details of this activity are not known, but at least 18 km^3 of juvenile dacitic



Tom Simkin *(left), curator of petrology and volcanology at the Smithsonian Institution's National Museum of Natural History, received the B.S. degree in civil engineering from Swarthmore College in 1955 and the Ph.D. degree in geology from Princeton University in 1965. In addition to global volcanism, his research inerests include the active volcanos of the Galápogos Islands and the ancient volcanos of the Isle of Skye, Scotland.*

Richard S. Fiske, *director of the Smithsonian Institution's National Museum of Natural History, received the B.S.E. degree in geological engineering from Princeton University in 1954 and the Ph.D. degree in geology from Johns Hopkins University in 1960. Currently he is studying active volcanos in the eastern Caribbean and ancient volcanics in the Sierra Nevada.*

The parallels in their careers extend back to the time the two authors played lacrosse against each other (unknowingly) in 1954 and toiled (separately) on ships of the U.S. Coast and Geodetic Survey.

This article is based on the authors' forthcoming book entitled Krakatau 1883: The Volcanic Eruption and Its Effects, *to be published this fall by Smithsonian Institution Press, Washington, D.C.*