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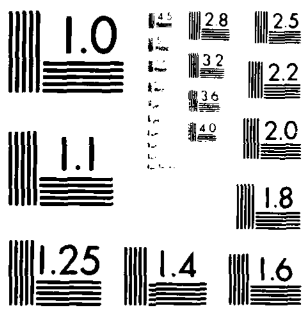

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ADVANCEMENTS IN CHINESE GEOMAGNETISM AND AERONOMY
DURING THE LAST THIRTY YEARS

by

Zhu Gangkun

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By: Zhu Gangkun

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ADVANCEMENTS IN CHINESE GEOMAGNETISM AND AERONOMY

DURING THE LAST THIRTY YEARS

by Zhu Gangkun

(Institute of Geophysics, Academia Sinica)

Abstract

This paper gives a systematic account of some advancements in the fields of geomagnetism and aeronomy in China during the last thiry years. The review covers the following 14 headings: (1) Establishment of geomagnetic observatories; (2) Geomagnetic surveys and charts; (3) Geomagnetic transient variation and geomagnetic storm prediction; (4) Rock magnetism, paleomagnetism, and archeomagnetism; (5) Magnetotellurgic prospecting and related problems; (6) Magnetic prospecting and interpretation of data; (7) Research on geomagnetic instruments; (8) Investigations and theoretical research of seismo-magnetic relations; (9) Statistical analyses of solar-terrestrial relations; (10) Structure of upper atmosphere and the determination of ozone layer; (11)Ionospheric measurements and analyses; (12) Structure and Disturbance of magnetosphere; (13) Studies on cosmic ray intensity variations:

(14) Retrospect and prospect.

[Text]

In the thirty years since the founding of the People's Republic of China, China has made great advancements in geomagnetism and aeronomy, yet the rate of progress has been unbalanced. Generally speaking, progress has been relatively slow and there is still a large gap with the internationally advanced nations. At present, all of China is working hard to realize the "four modernizations" and it is necessary to review the advancements in Chinese geomagnetism and aeronomy over the last thirty years and summarize our own positive and negative experiences.

1. Establishment of Geomagnetic Observatories

Before liberation, China only had the Yushan Observatory near Shanghai which was originally built by a French church. The Central Academy of Physics established a geomagnetic observatory in Nanking for a short time and during the war of resistance against Japan they set up an observatory at Yanshan in Guilin which was later moved to Chongqing. After liberation, under the enthusiastic promotion of the Academia Sinica's Institute of Geophysics, eight geomagnetic observatories were established: Peking Observatory (formal recording started in 1957), Lanzhou

Observatory (1959), Yushan Observatory (1877), Canton Observatory (1957), Changchun Observatory, Llasa Observatory and Urumqi Observatory. Besides these, to meet the need for geomagnetic measurement, there were geomagnetic observatories provisionally established in Tunhuang and Zhiya.

After the large earthquake at Xingtai in 1966, to actively coordinate earthquake prediction, under the strong support of the Academia Sinica and the National Earthquake Bureau, three key geomagnetic observatories were added at Hongshan in Longyao and at Qingguang in Tianjin. In the last several years, following the establishment of earthquake units in each province and city, various types of survey equipment began to be used all over China and the number of key observatories reached to over 141.

Among the geomagnetic observatories mentioned above, for the first eight established and the two observatories set up since the cultural revolution, the layouts of the observatory sites were homogeneous which developed the basis of geomagnetic observatories. Aside from the Urumqi Observatory, all of the other seven observatories issue formal recordings[1] and among them the quality of the Yushan and Peking Observatories is excellent. The other observatories are in the process of vigorous improvement.

2. Geomagnetic Surveys and Charts

Prior to 1936, geomagnetic surveying was all done by foreigners in China. Intermittently, 1,128 measurements were done[2].

Thirteen years before liberation, China began to carry out its own geomagnetic surveys and 127 surveys were done on the shores of the Yangtze River, on the Xisha Islands and Hainan Island and in the southwest. After liberation, under the guidance of the Geophysics Institute of the Academia Sinica, geomagnetic surveying increased tremendously. This work can be divided into three general stages. The first stage was from 1950 to 1959 during which time 235 points were surveyed; the second stage lasted until the beginning of the 1970's in which the range was larger and there were initial investigations of 1,740 spots; the third stage was significant in its surveying of long term changing points, the number was limited to under 100 and the area of Tibet was emphasized.

The main work of drawing up Chinese geomagnetic charts was done by the Geophysics Institute of the Academia Sinica. Based on the geomagnetic data collected within China, they compiled Chinese geomagnetic charts of 1950, 1960 and 1970. Most important were the D,I,H,Z value lines and the variation rate charts for other years which could provide a reference for national defense and industrial departments. During these three periods of Chinese geomagnetic charts, they naturally took the chart of 1970 as the best because they used data from more surveyed points (1,740), they gathered time variation patterns from seven Chinese and three Japanese geomagnetic observatories and the space distribution of surveyed points was more homologous than in the past.

At the same time, a written summary of the "analysis method of geomagnetic basic magnetic fields" was also completed [3]. From now on, the direction of work should be focused on the application of aerial surveys and satellite materials and we should begin developing research on long term variations and the generalized method.

3. Geomagnetic Transient Variations and Geomagnetic Storm Prediction

Before liberation, China had still not developed this area of research. The mass of geomagnetic data collected at the Yushan Observatory was suitable for analytical research of geomagnetic transient variation. For this, the Geophysics Institute of the Academia Sinica began work in the following areas in 1953: (1) statistical analyses of geomagnetic storms. A geomagnetic storm catalogue of the Yushan Observatory was completed for the years 1908-1956. The classification of geomagnetic storms was done on the basis of the properties of the violent starts and main phases of geomagnetic storms and statistics were made for the properties of each type of geomagnetic storm including the range of violent starts, the strength of geomagnetic storms and their season and the frequency of sunspot cycles. (2) They completed a K measurement index of the Yushan Observatory for the period 1922-1956 and carried out preliminary statistical analyses. Recently, detailed work has been done on the two above mentioned projects [4]. Geomagnetic bulletins are gradually developing in the geomagnetic observatories and have been providing timely references. Besides these, they have also determined curved magnetic disturbances, magnetic static sun and magnetic disturbance diurnal variation, and geomagnetic tides [5-6].

In the autumn of 1958, "magnetic storm, ionospheric disturbance and other methods of prediction" were first introduced and based on the "geophysical reaction of sun proton explosions", [7] related units of the Academia Sinica began routine predictions from sun activity and magnetic storms. It was practically proven that not only do magnetic storm predictions rely on effective information of sun activity but it is also necessary to pay close attention to the variations of the high altitude magnetosphere. To perfect and quantize magnetic prediction, it is necessary to expand and deepen work [8].

In recent years, from the interstellar shock wave-geomagnetic storm coupling relation which appeared form solar eruptions, statistical analysis was done on the interrelationship of solar eruptions and geomagnetic storms and an attempt was made to explain these theoretically [8a,8b].

4. Rock Magnetism, Paleomagnetism and Archeomagnetism

Chinese determination of rock specimen magnetism was begun early during the period 1951-1955 by each unit who coordinated magnetic prospecting and mainly determined the magnetism of rocks. Based on the size and other variations of rock and mineral magnetism, we could completely integrate the measured magnetic force abnormalities and the geological structures of the prospected areas. For earlier work, the reader is referred to references [9-12]. At present, this work is concentrated in the areas of geology, oil and metallurgy. Paleomagnetic measurement and research has been involved with the interpretation of the terrestrial pole position of each geological age and their shifts, the reversals of geomagnetic fields and crustal changes as well as the applications of stratigraphy and geotectology. In early work, reference [13] was based on three samples collected from Gansu and they determined the paleoterrestrial pole as being from the Silurian Period. Reference [14] used a non-directional magnetometer to determine the natural magnetic strength of 175 rock samples and calculated their paleoterrestrial pole position. These samples were collected from north, south and southwest China and were classified as being from five geological eras: the Devonian Period, the Carboniferous Period, the Permian Period, the Triassic Period and the Jurassic Period. In recent work, reference [15] used the alternating demagnetization method to carry out magnetic stability tests on Sinian system sandstone directional samples from Anhui's Xiuning District and gave their average magnetic strength direction and paleoterrestrial pole position. In a similar way, reference [16] carried out paleogeomagnetic research on two basalt section samples from the Nanking area whose geological era is being debated. In recent years, attention has been placed on the paleogeomagnetic determining of rock samples from the Tibetan plateau and the results are in the process of being collated. Reference [17] used the paleogeomagnetic method to measure for the first time the age of rocks transformed by man in Yunnan. They are about 1 million 700 thousand years old which is earlier than both Peking man and Lantian man. China is a nation with a very long history and civilization and using the magnetism of ancient samples (pottery, bricks, tiles, ancient relics etc.) they developed excellent conditions for archeogeomagnetic work. Reference [18] collected 40 ancient brick samples from the Han dynasty, Three Kingdoms Period and the Tang, Song, Jin, Yuan, Ming and Qing dynasties, processed 427 cubic samples and carried out measurement and gradual heating research on the magnetism of these samples. Thus, they initially determined the geomagnetic dip angle in the Peking area over the last 2,000 years and the geomagnetic field strength and their variations. Archeogeomagnetic work similar to that in the Peking area can without a doubt be extended to samples from other ancient cities and it is predicted that results will soon be published.

5. Magnetotellurgic Prospecting and Related Problems

Soon after liberation, when China was searching for oil gas structures and volcanic ores, the use of the natural electric field method was stressed [19-21]. At the same time, Chinese scholars published a series of articles [references 22-31] on various ellipsoid natural electric fields, data was collated on geoelectric currents and there was discussion on the problem of faults. Magnetotellurgic prospecting developed from the geoelectric current method began to be looked at seriously in China at the end of the 1960's and during the 1970's. Reference [32] emphasized the area from Wudu in Gansu Province to Yinchuan in the Ningxia Autonomous Region and at the same time the recorded time of geoelectric magnetic field disturbances was a few seconds to a few thousand seconds. From the measured results, they analyzed the northern section of China's north-south earthquake zone, the earth's crust, the electric features of the upper earth mantle and the electric diversity in earthquake and non-earthquake areas. In the last few years, related fields have continued to use the magnetotellurgic depth-sounder method to research the electric structure of certain crusts in Tibet. The results await publication. Besides these, reference [33] used records of bend disturbances and magnetic storm violent starts from the Peking, Changli, Tianjin and Dalian Geomagnetic Observatories and investigated the conductance abnormalities on the west shore of the Bohai Sea. Reference [34] stressed the records and analysis of 1-200 minute transient geomagnetic variations and abnormalities and their relations to earthquakes from six observatories in the eastern part of Gansu Province. Reference [35] gave a preliminary summary of the basic principles of magnetotellurgic prospecting.

6. Magnetic Prospecting and Interpretation of Data

Lately, magnetic measurement on the earth's surface and aero-magnetic measurement have been given serious attention by industrial departments. Its superiority was shown in its being able to attain a type of large scale geological concept in a short period of time for a tremendous surface area. China is a nation of many mountains and its mountainous areas occupy two-thirds of its area. After large scale work, the aero-magnetic measurement method has also made new advancements. Early, in 1966, reference [36] discussed several problems in the research of metallic ore area terrestrial magnetism. References [37-41] stressed the determination and explanation of magnetic abnormalities. In the last ten or more years, the development of magnetic prospecting and the interpretation of data has been mainly concentrated in industrial departments. Following the use of earth resources satellite photos and the United States plan to send up a geomagnetic satellite (Magsat) around September of this year, large area magnetic abnormalities will be discovered and explained and there will no doubt be extensive development.

7. Research on Geomagnetic Instruments

After liberation, there was great development in Chinese geomagnetic instruments. There were geological instruments such as the WCWI-63 model non-directional magnetometer, the CHD 5-72 model terrestrial nuclear turning magnetometer, the CCM-1 model

CCK-1

magnetic open gate magnetometer and various other resistance surveying instruments. In a radio factory in Anhui Province's Liuan District, there was also recently produced the QHXC-75 weight nuclear turning magnetometer. The Geophysics Institute of the Academia Sinica has developed the CB_2 triple quantity geomagnetic recorder and the CJ_6 model geomagnetic theodolite, yet they still await improvement.

In order for there to be a unified standard in China's station and field survey data, it was necessary to daily carry out absolute observation instrument constant determinations and comparisons using the Peking and Yushan Observatories as standards. At the same time, it was also necessary to improve the geomagnetic observation method and raise instrument precision, for example see references [42-46]. The use of the QHM nad BMZ instruments compare the instrument constants of each observatory and this has been carried out in the last few years as seen in reference [47a].

8. Investigations and Theoretical Research of Seismo-Magnetic Relations

Because of the demands of earthquake prediction, there has been development of investigations and research of seismo-magnetic relations over the last ten years. A special feature was the development of experience in measuring magnetism and in prediction, such as the "magnetic storm two fold method" "green and red light method" and the "magnetic storm nine fold method." However, there was the lack of a rational mechanism and model so that it was difficult to control and prove effective in practice. Attention was also given to industrial investigations and research. Reference [48] introduced the two analytical methods of "space interrelationship" and "phenomena interrelationship" for the use of geomagnetic field diurnal variation and based on the space interrelationship of the electromagnetic vertical weight of the Hongshan, Changli, Tianjin and Yushan Observatories and the Peking Observatory, the space interrelationship method was discussed for use in earthquake predictions. Reference [49] introduced the concept of the largest interrelated time and carried out preliminary research on the phase relations of the geomagnetic field vertical weight diurnal variations in two observatories. Related to the geomagnetic field diurnal variations, references [50-51], based on former work, introduced the local area geomagnetic diurnal variations analysis method and distinguished the geomagnetic local irregularities source field theory. At present, China also has several theories on the possible mechanism of earthquake relations. Reference [52] deduced a diffusion equation from Maxwell's equation which provided a basic equation of three dimensional electromagnetic induction, boundary conditions and a method for seeking solutions. Reference [53] considered that proceeding from the observed facts of the Xingtai earthquake in China and the geomagnetic variations, and because they used the piezomagnetic effect to explain the seismo-magnetic relation, thus, like the earthquake "expansion" theory, there was introduced the idea of geomagnetic field variations induced by the minute cracking and expansion in rocks in an earthquake focus area. Yet, reference [53a] pointed out that this "expansion" effect is very small. Reference [54] used the magneto-elasticity theory and recommended the simultaneous following of the earthquake wave propagation whereby the magnetic field will produce a disturbance. Under ideal conditions in which the conductivity is $\sigma \rightarrow \infty$, the magnetic field variation in the earthquake focus region is about several gamma order of magnitude. This type of magnetic disturbance still exists in limited conductivity conditions. Reference [55] calculated the electromagnetic reaction of electric conducting spheres in electric conductance random variations and attempted to link "electromagnetic warnings" appearing before a strong earthquake. This is possibly one type of "warning mechanism." Other problems related to seismo-magnetic relations can also be seen in references [32-34]. Reference [56] summarized new developments related to structural magnetics introduced in the 1975 International Special Topics Meeting held in Paris.

9. Statistical Analyses of Solar-Terrestrial Relations

Early work on solar-terrestrial relations emphasized the statistical analyses of phenomena and here I will only give a brief introduction. In recent years, the development of solar-terrestrial physics has been concentrated on research in the magnetosphere and aeronomy which are evaluated in another section of this article. References [58, 61-63] analyzed the relation of solar flares and magnetic storms. The relation of the position of solar flares on the sun's surface and magnetic disturbances was non-symmetrical and during the period 1938-1958 there were geomagnetic effects of large solar flares from the sun's γ and $\beta\gamma$ sunspots in magnetic field areas. Reference [57] has statistics on the magnetic disturbance solar terrestrial magnetic level strength solar mean value from 1923-1954 and large magnetic storms averaged a 27 day period. Reference [59] used the corona green area 5303 Å materials from the United States' Climax Observatory during the 1909-1952 period and analyzed its relation with K_p. Reference [60] estimated the sun's average wind velocity as 300-500 kilometers/second for the relation of the flocculus and reappearance of magnetic interference during the periods 1942-1943 and 1952-1953. References [64-65] gave two examples for the relation of a solar eclipse and the upper atmosphere and stressed the influence of solar ultraviolet radiation changes in the ionosphere and ozone layer. Reference [66] used the 1955 edition of the Greenwich catalogue on large magnetic storms to analyze the gradual solar temperature changes at nine stations between 1909 and 1952 in China.

10. Structure of Upper Atmosphere and Determination of Ozone Layer

China has still not systematically accumulated materials for determining the upper ozone layer. Up until recently, because the Doppler (?) spectrometer has been internationally corrected, two survey stations were established in Peking and in the southwest. References [67-70] discussed the reversal method and its improvement on the measurement of the vertical distribution of atmospheric ozone. There was great development in research on upper atmospheric structure, both in direct measurement and theoretical analysis. Direct measurement concentrated on less than 100 kilometers and used weather or sounding rockets to measure temperature, pressure and wind. For great altitudes, they used satellite orbit measurement and thus calculated upper atmospheric density and the earth's gravity [71-73]. In research on upper atmosphere types, references [74-76] discussed the dynamic transport and turbulent flow of the middle layer and heat layer atmosphere and their influence on the chemical composition following a high degree of distribution. References [77,77a] concerned with explanations and theories on the problems of upper atmosphere and dynamics, derived and discussed the heat atmosphere influence function (Green's function), the three layer layered type, the heat layer atmosphere tide differential operator and its eigenfunction and the diffusion wave in the upper atmosphere. References [78-82] analyzed and discussed two problems. For the first, there was analysis of the solar radiation heat source on the heat layer atmosphere and they discussed the relation of diffusion action and upper atmosphere wave motion. They also established a diffusion equilibrium solution in an electromagnetic field and in a gravitational field and managed the distribution of a 500-50,000 kilometer ion composition. For the second, there was analysis of the radiation absorption and transmission process and heat equilibrium and they discussed the influence of early condensation, radiation, atmospheric escape and hothouse effect on planetary atmosphere and surface heat. It was considered that for the origin of the earth's and planetary atmosphere, the earth should have a very primitive atmospheric stage and that its main feature is its abundantly filled hydrogen and its compound reduced atmosphere. In the international geophysics year, China imported from abroad a whole set of night and daylight observing instruments, yet because of system and personnel changes, the addition of observation points has not been fixed and thus up until now it still has not been put into operation. On the theoretical analysis of airglow, reference [83] analyzed the half width of the oxygen green line altitude section and the material on the nearest atomic oxygen altitude section. The tendency was towards the excitation mechanism which did not resemble the three level reaction proposed by Professor S. Chapman but was a two pole reaction. Reference [84] overlooked radiation transition and absorption. They first calculated the electron excitation speed of the energy level in an oxygen atomic ground state from the electron collision excitation cross-section and made hypotheses on the total collision excitation cross-section of neutral particles to attain a corresponding excitation speed. On this basis, they calculated the subenergy level excitation temperature in a 40-500 kilometer oxygen atom ground state.

11. Ionospheric Measurement and Analysis

Because short wave radio communications are closely related to ionospheric conditions, early, serious attention was given in China to ionospheric measurement and analysis. It became even stronger after the international geophysics year (IGY). At present, domestic ionospheric frequency measurement, besides a minority of one or two stations, is basically man operated. Yet, measuring stations are numerous and their distribution is good and they have amassed long term source materials. The Chinese Electric Wave Propagation Institute designed and developed a completely automatic ionospheric altimeter and successively equipped each station. Moreover, they are in the process of speeding up work on frequency conversion in order to make a standard curve. For early research on ionospheric measurement see reference [85a]. In recent years, the Department of Physics in Wuhan University has manufactured an ionospheric automatic oblique return detector and the Space Physics Institute very recently designed, manufactured and researched an ionospheric electron capacity 505A model polarimeter and carried out receiving tests[85].

Early, domestic ionospheric analysis was also developed [86-89]. References [86] and [87] introduced the intersecting point correlative method and the ten point correlative method to analyze the statistical properties of vertically reflected quadratic echos for the ionosphere. References [88] and [89] analyzed the sunrise effect in the ionosphere's E and F layers and proved that the drift theory proposed by Dr. D.F. Madding was insufficient to explain the F_2 abnormality. During the 1977 and 1979 academic conferences, papers focused on aspects of the ionosphere showing the advances made in recent years. They can be divided into four areas: first was the sorting out of materials on vertical measurement and the conversion method of ionospheric electron concentration section structure [90-94]. Second was ionospheric frequency calculations, regular ionosphere and E_S information channel properties and the problem of the ionospheric refraction effect [95-99]. Third was the analysis of features of certain Chinese area low ionosphere and ionospheric disturbances [100-104]. Fourth were references [105-111] which included the use of noise and other measures to calculate ionospheric parameters, the produced Doppler shift integral effect when high frequency electric waves pass ionospheric reflection, the influence of galactic cosmic rays on the ionosphere and the mutual action of electric waves, aerials and plasma.

12. Structure and Disturbance of Magnetosphere

Early work stressed theoretical analysis. References [112-114] touched upon the changes of external radiation band structures in magnetic storms and discussed a type of mechanism of charged particles passing into a geomagnetic field. References [115-116] focused on the qualitative appraisal of violent starting magnetic storms and the longitudinal non-symmetricality of the main phase of a magnetic storm. References [117-119] analyzed the movements of charged particles in geomagnetic fields and neutral line magnetic fields and they vigorously initiated simulated tests. References [120-121] summarized the propagation of magnetic fluid shock waves and based on the cosmic ray Forbush descent, they calculated the solar flare shock wave near the earth's orbit. China's putting a satellite into orbit created excellent conditions for space particle and magnetic field measurement and references [122-124] provide many examples representing this aspect of research. During the 1979 Solar-Terrestrial Physics Academic Conference, focus was placed on discussing solar eruptions, solar wind and magnetospheric substorms, especially the mechanism of magnetospheric substorms [125-127]. References [128-129] introduced a theoretical model of a satellite with a charged surface. References [130-131] discussed the geomagnetic field magnetic coordinates.

13. Studies on Cosmic Ray Intensity Variations

In the international geophysics year, China established observatories on Peking, Wuhan, Canton and Luoxue in Yunnan Province. However, at present, only the Peking Observatory maintains a neutron pile, an ionization chamber and a μ meson telescope with three types of conventional observation. The other three observatories were soon discontinued. Early recording was good. For example, reference [132] wrote about the atmospheric pressure corrections of the cosmic ray neutron composition in the Peking and Luoxue Observatories. However, in recent years, for various reasons, regular observations and analyses still await reorganization and restoration. There have been a series of articles published on solar cosmic ray propagation. References [133-135] discussed the propagation of solar cosmic rays in interplanetary spaces including diffusion in interplanetary irregular magnetic fields and the two physical processes of solar wind and convection. For this, they used the non-dimensional constant to show particle diffusion and convection characteris-tics, sought a diffusion convection equation solution in a homogeneous infinite medium and attempted to use propagation correction in a solar proton event energy spectrum. References [136-138] took the interplanetary large scale fan shaped magnetic field as the basis to research the fan shaped coordinate system of solar cosmic rays in interplanetary propagation and derived a propagation equation of solar cosmic rays in this type of coordinate system. Later, they further used the fan shaped coordinate system to discuss propagation and earth orbit modulation of Jupiter electrons in interplanetary space and set up a three dimensional diffusion model for solar cosmic ray diffusion. The reader is referred to reference [139] for the contents of cosmic ray intensity variations.

14. Retrospect and Prospect

It can be seen from the above review that in the last thirty years China has made great advancements in geomagnetism and aeronomy and this has played a great role in building national defense and the national economy. On the one hand, the motive force for these advancements is owing to the task carrying the field of study and the field of study promoting the task. On the other hand, after determining long-range and annual plans for scientific and technological advancement, there has been continual support. However, many problems still exist, for example, the speed of development and the growth of personnel are too slow. In the last thirty years, there have only been 4-5 academic conferences related to this field (the first was in February, 1957, the second in September, 1963, the third in September, 1976, the fourth in February, 1979 and besides these there was a conference in November, 1977 which was limited to ionospheric physics). The proportion of articles in journals related to geomagnetism and aeronomy is not very large and this cannot meet the needs of the "four modernizations." Furthermore, the development of each branch of geophysics has been unbalanced. During the 1950's, more stress was placed on geophysics, meteorology and seismology. After the international geophysics year and the beginning of the 1960's, there was development in geomagnetism and aeronomy. During the cultural revolution, all natural sciences, including geophysics, were effected by the impact of "ultraleftist" thought. In recent years, there has been notable development in geophysics, meteorology and especially seismology and when comparing, the development of geomagnetism and aeronomy depends on unified recognition and the adoption of measures for the impetous to catch up.

At present, there is still a large gap between China and the advanced international level which is seen in basic construction, the use of advanced technology and the development of advanced original theories. Taking international magnetosphere study (IMS) as an example, in the vigorous development of international magnetosphere studies, the period 1976-1979 was one in which the whole world went from ground to outer space overall observation, and 1980-1981 is a period of data analysis and thorough research. When China first began work in this field, it depended on reorganizing China's various ground observations developed since the IGY and there are plans to develop the use of new IMS equipment, carry out thorough research, make foreign things serve China, be based on the domestic and actively develop research on the magnetosphere and the solar-terrestrial relation [140]. Hereafter, in the area of basic construction, we should pay attention to maintaining the relative stability of the system of organization and industry, speed up the training of qualified personnel and quicken the filling in of the national defficiency in departments. It is also necessary to give attention to the quality of observatory materials and the fast processing of electronic computers. In the area of using advanced technology, we should pay attention to China's national conditions and economic effects. For example, in developing space technology and surveying, we can concentrate our strength on close areas, the small-scale or special characteristics and when study and achievement are joined we can at the same time tap the potential doers of the ground. In the area of theoretical research, we should promote the use of physics and mathematics theories to disclose the mechanism of geomagnetic and aeronomy phenomena and processes, utilize modern technology in understanding the basis of the microprocess to seek the macrolaw of natural change. At the same time, we should give attention to the mutual permeation of each discipline, expand and develop various types of discipline activities, strengthen domestic and international exchange and with continuous liberated thought vigorously cooperate and open up new roads in this branch of learning.

Summary

ON SOME ADVANCEMENT OF CHINESE GEOMAGNETISM AND AERONOMY DURING 1949—1979

Tschu Kang-kun

(Institute of Geophysics, Academia Sinica)

This paper gives a brief account of some advancement in the field of geomagnetism and aeronomy in China during the period of 1949—1979. The review covers the following 14 headings: (1) Establishment of geomagnetic observatories; (2) Geomagnetic surveys and charts; (3) Geomagnetic transient variation and geomagnetic storm predication; (4) Rock magnetism, paleomagnetism and archeomagnetism; (5) Magneto-telluric prospecting and related probems; (6) Magnetic prospecting and interpretation of data; (7) Some research on geomagnetic instruments; (8) Search of seismo-magnetic relations; (9) Statistical analyses of solar-terrestrial relations; (10) Structure of upper atmosphere and determination of ozone layer; (11) Ionospheric measurements and analyses; (12) Structure and disturbance of magnetosphere; (13) Studies on cosmic ray time variations; and (14) Retrospect and prospect.

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