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Ionospheric Precursors of Earthquakes

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Preface

Using the kind permission given to me by my co-author, this short preface will be written in my name.

I want to devote this book to San Juan city in Argentina. It is not only due to the fact that the city was twice completely destroyed after the devastating earthquakes in 1941 and 1977, but also because my stay there completely changed my life. Changes included changing my career from the field of space plasma physics to Earth sciences and geophysics, and changes in my personal life giving me happiness and compliance in my present family.

Going back to the subject of the book, it should be noted that the history of the question asked by the book is very complicated and intricate. Starting in the 1930s from the observation of seismogenic electric fields, the area of seismo-ionospheric coupling became an area of fighting and conflicts, hopes and frustrations. Speculation and misunderstanding on the interdisciplinary borders made this field for many years (even up to now) taboo for so-called "serious scientists". But due to the courageous efforts of several groups in Russia and the former USSR states such as Kazakhstan and Uzbekistan, Japan, later France and Taiwan, Greece and Italy the situation started to improve. From the late 80-th — early 90-th regular workshops started to be organized both as separate events (like the Chofu workshops in Japan), and within the framework of the World's main scientific Assemblies and conferences such as URSI, IAGA, EGS and COSPAR General Assemblies, Wroclaw International Symposium on Electromagnetic Compatibility, PIERS, WPGM (Western Pacific Geophysical Meeting) etc. This intensive work led to two major results. First, the field of seismo-ionospheric coupling and the electromagnetic precursors of earthquakes started to be acknowledged and internationally coordinated. The common working group of URSI commissions E, G, H on Lithosphere-Atmosphere-Ionosphere Coupling was organized coordinating this activity within URSI, and in 2002 the IAGA-IASPEI-IAVCEI Inter-Association Working Group on "Electromagnetic Studies on Earthquakes and Volcanoes (EMSEV)" was organized.

The second very important result is that governmental bodies in different countries started to be involved in the practical application of the results of seismo-ionospheric coupling studies which led to the financing of several projects of ground based observations (FRONTIER projects in Japan, iSTEP project in Taiwan, PREVENTION project in Mexico), and satellite based studies of the ionospheric precursors of earthquakes: DEMETER (France), Warning and Variant (Ukraine), COMPASS and Vulkan (Russia), and the ESPERIA mission (Italy).

The lithosphere-atmosphere-ionosphere coupling is a very complicated subject involving a lot of physical effects and interactions on all levels starting from underground up to the Earth's magnetosphere. The volume of knowledge stored up to now is so large that it is impossible even in a short time to research all available directions. So we decided to limit ourselves to the following. There is the natural divide in the subject reflected in the existence of two groups of scientists. One of them is involved in studies of seismo-electromagnetic phenomena expressed mainly in electromagnetic emissions and fields associated with the seismic activity, and another one — dealing with ionospheric and space plasma variations observed before the approaching earthquakes. Our book will concentrate on the second of these two areas of research. This can be explained in two ways. Firstly, it is very natural as the authors belong to the second group, and the second reason is that the number of publications on seismo-electromagnetic noises is essentially larger than publications on ionospheric phenomena. So we decided to fill this gap by describing the underlying physical mechanism and systemizing the information on ionospheric precursors of earthquakes.

The book consists of 7 chapters. Taking into account the multidisciplinary character of the described subject the first chapter is devoted to main composite constituents or fields of science involved in seismo-ionospheric coupling. It provides elementary knowledge on the main terms of seismology, ionosphere, radiative plasmachemistry and atmospheric electricity.

The second chapter gives an idea of how look the ionospheric precursors, the techniques of its registration.

The model description is concentrated in Chapters 3 and 4. Chapter 3 describes the physical mechanism of anomalous electric field generation and presents the new conception of near ground atmospheric plasma. Chapter 4 is devoted to the physical mechanism of the electric field penetration into the ionosphere and its effects in the ionosphere and magnetosphere.

To be able to distinguish the ionospheric precursors from the other kinds of ionospheric variability it is necessary to know their main morphological features. Chapter 5 is devoted to their description.

Working with something that has the name "precursor", it is impossible to avoid the questions of practical application. Some of our approaches to practical application of the ionospheric precursors are posed in Chapter 6.

Seismo-ionospheric coupling is a science which is developing now, in our eyes, so there still exist issues which are not well established and proved. The seventh chapter is devoted to issues not as yet clarified but which have a relation to seismo-ionospheric coupling, and describes some very new results obtained during the writing of the book. It also deals with the future directions of our studies.

Such multidisciplinary study is impossible without involving a large scientific community, experimental and theoretical work. So we would like to thank all the people who helped us in our studies. First of all, our colleagues from the IZMIRAN Ionospheric Department, which I headed for many years. And personally I would like to thank Valery Hegai whose important contribution to this work, especially Chapter 4, is difficult to overestimate. His kind but firm support and valuable comments helped very much. I also want to thank our colleagues Anna

Legen'ka, Victor Depuev, Tamara Gaivoronskaya, Alexei Lomonosov, who are our co-authors in many publications devoted to seismo-ionospheric coupling.

My appreciation also to my brother-in-arms, Prof. J. Y. Liu, now Director of the Institute of Space Science, National Central University, Taiwan. A lot of results from Taiwan contributed to our model substantiation, and my fruitful multiple stays in Taiwan always gave inspiration for future work.

Many thanks to our colleagues from different institutions who are working in the field of electromagnetics, ionospheric precursors, and seismology: Hiroshi Kikuchi, Seiya Uyeda, Masashi Hayakawa, Oleg Molchanov, Michel Parrot, Friedemann Freund, Dimitar Ouzounov, Pier Francesco Biagi, Manuel Hernandez-Pajares, Ramesh Singh, Mikhael Gokhberg, Vladimir Kostoglodov, Yuri Taran, Amando Leyva Contreras, Sinna Lomnitz, and many-many others who contributed to our work by fruitful discussions and comments.

I should thank P. Hollis-Watts whose completely new results on the pulsed emission before the earthquakes in Western Australia were obtained as a result of his enthusiastic and voluntary work.

It should be mentioned also that without the friendly and creative atmosphere surrounding me at the Institute of Geophysics of UNAM this book would never have been finished.

We also want to thank our opponents who helped to sharpen our arguments and convince us of our rightness.

Chapters 1, 2, 4, 5, were written by S. A. Pulinets, Chapter 3 — by K. A. Boyarchuk, and Chapter 6 and 7 — by S.A. Pulinets and K.A. Boyarchuk.

Sergey Pulinets

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