National Institute of Advanced Industrial Science and Technology
AIST

DPRC Disaster Prevention Research Center
National Cheng Kung University

Final report of an international cooperative research titled "Hydrological and geochemical research for earthquake prediction in Taiwan (February 2002 - March 2005)" and Proceedings of the third Japan-Taiwan International Workshop on Hydrological and Geochemical Research for Earthquake Prediction

Edited by
Naoji Koizumi, Norio Matsumoto and Chjeng-Lun Shieh

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GEOLOGICAL SURVEY OF JAPAN
NATIONAL INSTITUTE OF
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1-1 Higashi 1-Chome, Tsukuba, Ibaraki, 305-8567 Japan
2005

Final report of the cooperative research titled " Hydrological and geochemical research for earthquake prediction in Taiwan" during the period from February 2002 to March 2005

1. Introduction

During the period from February 2002 to March 2005, the Institute of Geoscience (IG-GSJ) or Institute of Geology and Geoinformation (*IGG-GSJ), Geological Survey of Japan, the National Institute of Advanced Industrial Science and Technology (AIST) and Disaster Prevention Research Center, National Cheng Kung University (DPRC-NCKU), Taiwan carried out cooperative research activities on (1) Investigation of groundwater anomalies associated with the earthquake in Taiwan; (2) Analysis of the natural groundwater level changes in correlation to the geotectonic and meteorological activities; (3) Improving methodologies in monitoring and studying the groundwater anomalies with respect to geotectonic activities and/or other aspect as well; (4) Compiling the future periodically-monitored information of groundwater chemical and physical properties, and geotectonic anomalies; and (5) Analysis of the groundwater anomalies as earthquake precursors.

The aims of the project were to evaluate the relationship between groundwater changes and earthquake occurrences in Taiwan and to make progress in hydrological and geochemical researches for earthquake prediction.

(*: The Institute of Geoscience (IG-GSJ) was re-organized and renamed the Institute of Geology and Geoinformation (IGG-GSJ) on May 1, 2004.)

2. Participation

2-1 IG-GSJ Participation

Naoji Koizumi:	Leader of Tectono-Hydrology Research Group, IG-GSJ
Makoto Takahashi:	Senior Research Scientist, IG-GSJ
Norio Matsumoto:	Senior Research Scientist, IG-GSJ
Tsutomu Sato:	Senior Research Scientist, IG-GSJ
Ryu Ohtani:	Research Scientist, IG-GSJ
Yuichi Kitagawa:	Research Associate, IG-GSJ

2-2 DPRC-NCKU Participation

Chjeng-Lun Shieh:	Director, DPRC;
Sen-Yuan Lee:	Leader, Engineering Division, DPRC
Jinn-Chyi Chen:	Leader, Surveillance Division, DPRC
Chih-Ming Tseng:	Associate Researcher, DPRC
Yuan-Fan Tsai:	Associate Researcher, DPRC
Wen-Chi Lai:	Assistant Researcher, DPRC
Pei-Hua Yen:	Professor, Institute of Hydraulic and Oceanic Engineering, National Cheng Kung University (hereinafter referred to as “NCKU");
Jan-Chyan-Deng:	Professor, Institute of Hydraulic and Oceanic Engineering, NCKU

Ching-Weei Lin: Associate Professor, Institute of Earth Sciences, NCKU
Ming-Chee Wu: Associate Professor, Institute of Earth Sciences, NCKU
Chen-Feng You: Associate Professor, Institute of Earth Sciences, NCKU
Youe-Ping Lee: Senior Engineer, Water Resources Bureau, Ministry of Economic Affairs, the Republic of China

3. Review of main activities

February 2002: Mr. Lai came to IG-GSJ and study groundwater observation system of IG-GSJ. He also researched the groundwater anomalies in Taiwan caused by 1999 Chi-Chi Earthquake in cooperation with the above members of IG-GSJ. His stay in IG-GSJ was about 1 month.

September 2002: Japan-Taiwan International Workshop on Hydrological and Geochemical Research for Earthquake Prediction was held at IG-GSJ. A few of above members of DPRC-NCKU stayed in Tsukuba for about 1 week and exchanged methodologies, data and experience of investigation in groundwater anomalies associated with earthquakes.

September 2003 : The second Taiwan-Japan International Workshop on Hydrological and Geochemical Research for Earthquake Prediction was held at DPRC-NCKU.

May 2004 : Mr. Lai came to IG-GSJ and had the presentation related to the cooperative research in the 2004 Joint meeting for Earth and Planetary Science in Japan.

September 2004 : The Third Japan-Taiwan International Workshop on Hydrological and Geochemical Research for Earthquake Prediction was held at IG-GSJ. A few of above members of DPRC-NCKU stayed in Tsukuba for about 1 week and exchanged information related to the recent results with Japanese researchers.

4. Results

Through the three-year cooperation, we have made remarkable progress in Hydrological and geochemical research for earthquake prediction in Taiwan. Through exchanging the information of the groundwater observation system with the researchers in IG-GSJ, DPRC-NCKU has made its own groundwater observation system for earthquake prediction research and is accumulating the data of earthquake-related groundwater changes.

The combination of 8 well-equipped observation wells with the 550 wells that have been originally designed for water resource management by the Water Resources Bureau, Ministry of Economic Affairs has given detailed and abundant information for earthquake-induced groundwater level changes. Such information has enabled us to understand and develop the past similar researches. The comparison of the observed coseismic groundwater level changes to the inferred coseismic volumetric strain steps have been well investigated. The liquefaction and permeability enhancement, which also cause earthquake-related groundwater changes, have also been studied related to the geological setting and seismic ground motion. Thus theoretical approaches for clarifying the mechanism of earthquake-related groundwater changes have been improved.

We especially clarified the mechanism of groundwater changes caused by the 1999 Chi-Chi earthquake and presented two papers in the international journals.

5. Prospects in the future cooperation

Both Taiwan and Japan are situated in the boundary zone between the Eurasian and Philippine Sea plates and often attacked by large earthquakes. DPRC-NCKU has now abundant data produced by the dense groundwater observation network. IGG-GSJ has 30-year experience of the hydrological and geochemical research for earthquake prediction. Therefore continuous cooperative research of DPRC-NCKU and IGG-GSJ will give much contribution to hydrological and geochemical research for earthquake prediction. Therefore DPRC-NCKU and IGG-GSJ have decided to continue this cooperative research for next 5 years. We are sure that the cooperative research will make much contribution to reducing earthquake hazards in Taiwan and Japan in future.

6.Publications

6-1 In English

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Han Y. L., M. C. T. Kuo and Y. P. Lee (2004) Monitoring of Radon in Taiwan Groundwaters, Geological Survey of Japan Open-File Report, 403.

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Wang C.L. and K. C. Hsu (2004) Building a "hydrological model" on an "equation friendly" platform, Geological Survey of Japan Open-File Report, 403.

6-2. In Chinese

Dung, C.-C. and K.-C. Hsu, (2003) Fractal analysis of the impact of Chi-chi earthquake on the subsurface hydrological system, Journal of Taiwan Water Conservancy, 51(4), 78-88.

Dung, C.-C. and K.-C. Hsu, (2003) On estimating the Chi-Chi earthquake-induced changes in hydrogeological properties of the Chushuishi Alluvial fan, Mining 47(2), 152-161.

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Wang, S.-J., and K.-C. Hsu (2004) Using the stochastic approach to derive governing equations of the poroelasticity theory, Proceeding of the 1st Resources Engineering Conference, p.p. HG-6.

6-3 In Japanese

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The Third Japan-Taiwan International Workshop on Hydrological and Geochemical Research for Earthquake Prediction

7 September, 2004

Meeting Room No.2, Geological Survey of Japan, AIST*

PROGRAM

9:00〜10:00

Registration

Morning Session (10:00〜12:10)

10:00〜10:10

Opening Remarks

Tsukuda, E. (Director of Geologial Survey of Japan, AIST)

10:10〜10:40

Nakamura, M. (Ryukyu Univ.) : 3-D Seismic Tomographic Imaging in Eastern Taiwan - Southwestern Ryukyu Regions <abstract> <presentation>

10:40〜11:10

C-H. Tsai (CWB) : GPS and Groundwater Observation on Precursor Studies in Taiwan <abstract> <presentation>

11:10〜11:40

Tokunaga, T. (Univ.Tokyo) : Anisotropic Poroelasticity of Rocks and Its Effective Stress Dependency <abstract> <presentation>

11:40〜12:10

Matsumoto, N. (GSJ): Hydrological Changes in Response to the Tokachi-oki Earthquake in 2003, Japan <abstract> <presentation>

12:10〜

Photographing at the front of the main entrance of Geological Survey of Japan, AIST

Lunch (12:30〜13:50)

12:30〜13:50

Business meeting at room 443 of Geological Survey of Japan, AIST

Afternoon Session (13:50〜18:10)

13:50〜14:20

Tasaka, S. (Gifu Univ.): Underground Water Observation in "Wari-ishi Hot Spring", Gifu Prefecture <abstract> <presentation>

14:20〜14:50

Tsunomori, F. (Univ.Tokyo) : Improvement of Pumping System for Continuous Monitoring of Dissolved Gas in Groundwater <abstract> <presentation>

14:50〜15:20

Kitagawa, Y. (GSJ): Estimation of Barometric Responses of Groundwater Levels at Observation Stations of the Geological Survey of Japan, AIST <abstract> <presentation>

15:20〜15:50

C-C. Yang (WRA): Groundwater Observation Network of Taiwan and Its Meaning to the Earthquke-Induced Hydrological Changes <abstract> <presentation>

15:50〜16:20

Break

16:20〜16:50

W-C. Lai (DPRC, NCKU): Coseismic Groundwater Level Changes and Its Mechanism of Taiwan, 2003 - 2004 <abstract> <presentation>

16:50〜17:20

Koizumi, N. (GSJ): Review of Cooperative Hydrological and Geochemical Research for Earthquake Prediction in Taiwan for Recent Three Years <abstract> <presentation>

17:20〜18:10

Discussion

18:10〜20:00

Banquet at a restaurant in AIST

* AIST: National Institute of Advanced Industrial Science and Technology
CWB: Central Weather Bureau, Taiwan
DPRC, NCKU: Disaster Prevention Research Center, National Cheng Kung University, Taiwan
GSJ: Geological Survey of Japan, AIST
NSC: National Sciences Council, Taiwan
WRA: Water Resources Agency, Ministry of Economic Affairs, Taiwan