

# 京都大学の志田先生とレボイル・パシュウイツ傾斜計

Prof. Shida and the Rebeur-Paschwitz tiltmeter  
at Kyoto University

James Mori

Kyoto University, Disaster Prevention Research Institute

## *1. 1999 Kyoto University*

When I came to Kyoto University in 1999, the Geophysics faculty meetings were held in a rather small and dark room in the basement of the Graduate School of Science Building 4. I could not understand much of the discussions at the meetings and would spend time looking around at the walls and small windows of that room. Often I would look at the relief portrait of Prof. Toshi Shida (Fig. 1), although at the time I did not know who this was.



Fig. 1. Relief portrait of Prof. Toshi Shida which was in the meeting room of Building 4 and now in Room 563 of Building 1.

Several years later, when I saw the small exhibit on the third floor of Building 6 (Fig. 2), I found out that the portrait I looked at during the faculty meetings was Prof. Shida. That reminded me that when I was a graduate student at Columbia University, there was a question about the Shida number on a test and I could not answer the question. After the test, I learned the Shida number was related to the gravity potential of the moon. It was interesting to me that this person of the Shida numbers was the first geophysics professor at Kyoto University.



Fig. 2. Geophysics exhibit on the 3<sup>rd</sup> floor of Building 6.

## ***2. Rebeur-Paschwitz instrument***

The story continues in 2007 when I met my friend, Prof. Luis Rivera, from Strasbourg University, France at the American Geophysical Union (AGU) Fall meeting in San Francisco. At AGU people often see each other on the escalators that move in opposite directions. If you are going down, it is easy to see and recognize many people going up. I was going down and I saw Luis going up, and he yelled at me that he wanted to talk to me.

Later that day we met, and Luis showed me copies of letters written in the 1890's from Prof. Hantaro Nagaoka and Prof. Fusakichi Omori (Fig. 3) to a company in Hamburg, Germany, about purchasing two Rebeur-Paschwitz tiltmeters for recording earthquakes in Japan (Fig. 3). There also was a photo of the instrument (Fig. 4).

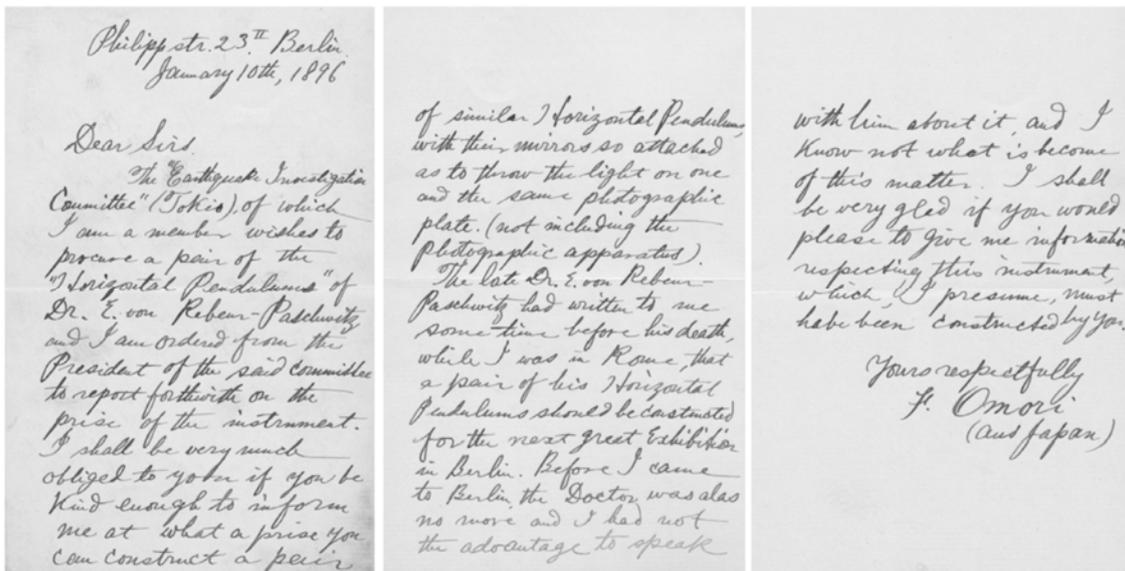


Fig. 3. Letter written on 10 January 1896 by Prof. Omori on behalf of the Earthquake Investigation Committee, to the A. Repsold & Soehne company in Hamburg.

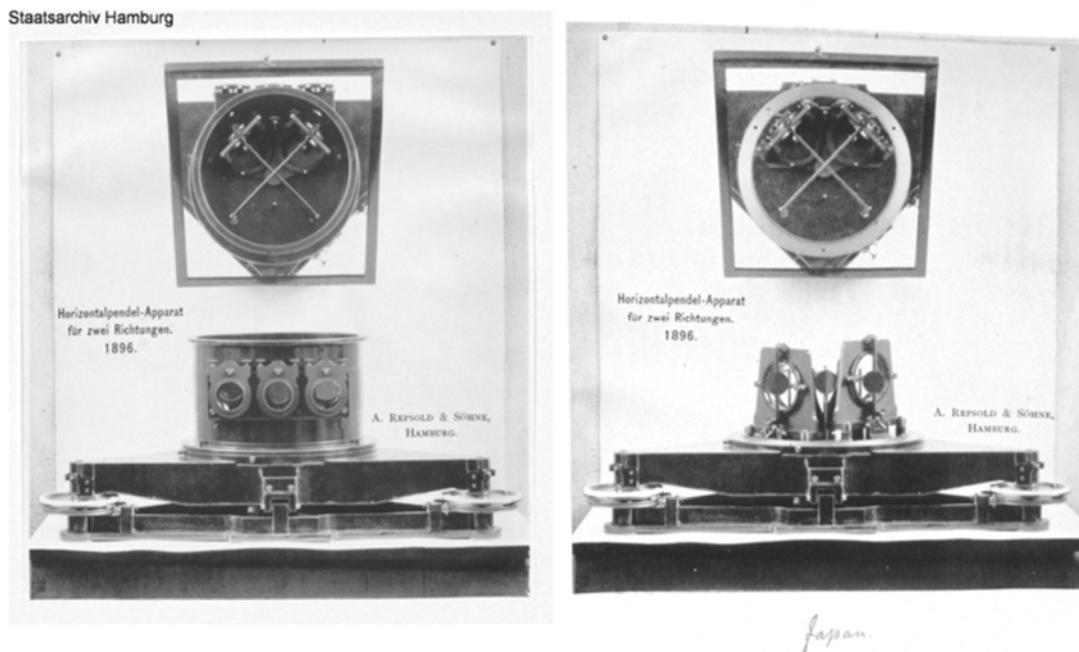


Fig. 4. Photo of Rebeur-Paschwitz instrument ordered by the Earthquake Investigation Committee in Japan.

Luis has a keen interest in old geophysical instruments and has been trying to track down as many as possible of the Rebeur-Paschwitz instruments. He wanted to know if the two that were sent to Japan were still in existence somewhere.

This instrument is famous in seismology because it was used in recognizing the first far distance (teleseismic) recording of an earthquake. Today, we routinely study earthquakes using seismic stations from around the globe, but this example in 1889 from Potsdam, Germany of a reported earthquake in Japan, showed for the first time that an earthquake could be well recorded on the other side of the Earth. The exciting finding was reported in *Nature* 40, pp. 294-295, 1889, 'The Earthquake of Tokio, April 18, 1889 by E. von Rebeur-Paschwitz.

Actually, we now think that the earthquake recorded in 1889 at Potsdam did not occur in Japan. The amplitude in Potsdam seems too large for the M5.8 Tokyo earthquake that was reported in a Japanese newspaper. The earthquake on the Potsdam record was probably a larger earthquake that

occurred at a different location.

Ernst von Rebeur-Paschwitz was a German researcher in physics and inventor of this pendulum instrument. The concept of the instrument is relatively simple and consists of two perpendicular horizontal pendulums. The strong point of the instrument is the stability and accuracy of the pendulums (natural period of about 10 sec) for measuring horizontal ground motions. The pendulums can also be used to measure long-period tilt, so this instrument is often called a tiltmeter.

### ***3. Rebeur-Paschwitz tiltmeter in Japan***

With the help of Prof. Shuzo Takemoto of Kyoto University, we were able to learn the history of one of the two Rebeur-Paschwitz tiltmeters that were sent to Japan. The locations where the instrument was operated are shown in Fig. 5.

1893-1896

Two Rebeur-Paschwitz tiltmeters were made by the A. Repsold & Soehne company in Hamburg, with correspondences between the company and Nagaoka and Omori.

1900-1909

The instruments were shipped to Omori at the Imperial University in Tokyo. There are no known publications of recordings from these instruments at that time. It is speculated that these sensitive pendulums, which could record earthquakes at far distances, were not very suitable for recording the stronger shaking from nearby earthquakes in Japan. Also, around this time Omori developed his own instrument (Omori seismograph) which became widely used for local earthquake recording in Japan.

1909-1932

In 1909, Shida became the first geophysics professor at Kyoto Imperial University and brought with him one of the Rebeur-Paschwitz tiltmeters. At that time the instrument was reportedly stored in a box at the entrance to

Omori's laboratory in Tokyo. Prof. Dairoku Kikuchi (president of Kyoto Imperial University) knew about this and suggested to Shida that he negotiate with Omori about using the instrument, since it was not being used. Shida was successful in obtaining the instrument.

During this time the Rebeur-Paschwitz tiltmeter was operated at Kamigamo Observatory in Kyoto by Shida. It was during this period that Prof. Shida made the first observations in Japan of the Earth tides using the instrument. He also published his famous paper in 1912 which describes the Shida number which quantifies the gravitational effect of the moon on the marine tide.

1932-1937

Following an earthquake in Fukuoka in 1930, Prof. Kenzo Sassa took the Rebeur-Paschwitz tiltmeter to Aso Observatory of Kyoto Imperial University. It was operated there for five years.

1937- ?

The Rebeur-Paschwitz tiltmeter was brought back to Kamigamo Observatory. There were comparison tests with the Ishimoto tiltmeter operating at nearby Abuyama observatory. Data from these tests are reported in papers by Sassa and Nishimura in 1940 and 1941.

After this, there is no record of the instrument. A pamphlet from 1959 mentions 3 types of instruments that were operating at Kamigamo Observatory, but the Rebeur-Paschwitz tiltmeter is not mentioned.

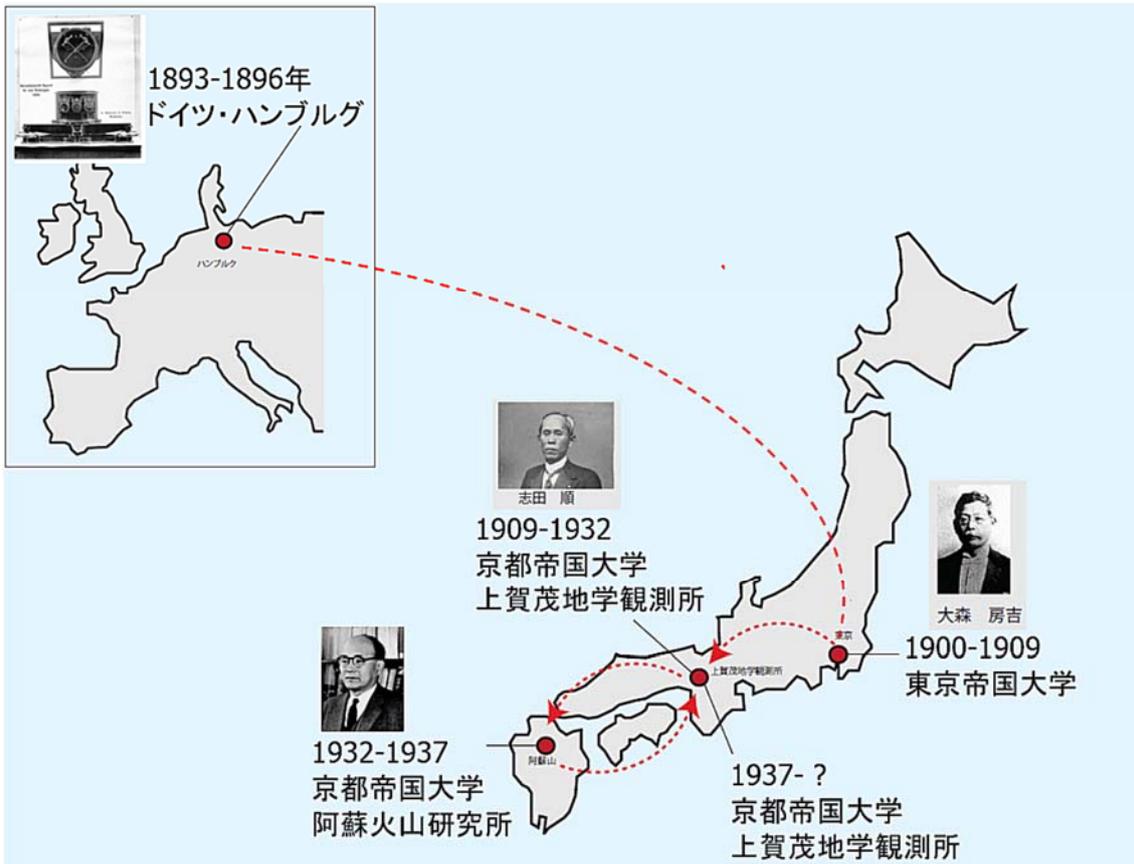


Fig. 5. History of the Rebeur-Paschwitz tiltmeter in Japan

#### 4. Rediscovery of the Rebeur-Paschwitz tiltmeter

With the information that the Rebeur-Paschwitz tiltmeter was last operating at Kamigamo Observatory during the 1930's, we visited the observatory in April 2008 with hopes of finding the old instrument (Fig. 6). We spent the morning looking around the observatory, which is still used as a seismic station. There were Weichert and Omori seismographs which were not operating but preserved in very good condition (Fig. 7). There were also old seismograms dating back to the 1930's which were not kept in a very well organized state (Fig. 7). Unfortunately, we could not find any sign of the Rebeur-Paschwitz tiltmeter.



Fig. 6. Visiting Kamigamo Observatory in April 2008.



Fig. 7. Omori seismograph (left) and old seismic records (right) at Kamigamo Observatory

A year later in July 2009, Luis Rivera visited Kyoto and wanted to see the Kamigamo Observatory. We visited the observatory on a sunny summer

morning (Fig. 8) and saw the various old seismographs and vault where the Rebeur-Paschwitz tiltmeter was probably operated. I was walking around outside the observatory, and suddenly heard Luis' voice, 'Jim, Jim come here'. I was a bit worried because I thought that Luis might have accidentally injured himself. When I found Luis, he was kneeling next to a pile of debris which had old wooden planks and metal pieces from old instruments in the assortment of junk (Fig. 9). After moving aside the wooden planks, Luis had found the old Rebeur-Paschwitz tiltmeter in this pile of garbage! There was no mistaking the instrument with the rusted circular casing and remnants of the frames that held the two horizontal pendulums. Also, the A. Repsold & Soehne company name was clearly preserved on the outside of the casing (Fig. 10). The instrument was quite heavy, so we left it inside the observatory building and came back to retrieve it a week later.



Fig. 8. Prof. Luis Rivera of Strasbourg University at Kamigamo Observatory



Fig. 9. Finding the Rebeur-Paschwitz tiltmeter in a debris pile at Kamigamo Observatory in July 2009.



Fig. 10. The Rebeur-Paschwitz tiltmeter found at Kamigamo Observatory in July 2009.

It was an exciting find and we both felt exhilarated on the short trip back into the city. It had been about 70 years since there was any record of the instrument and we felt a sense of history in finding and holding the instrument that Shida had used. It is also remarkable that we rediscovered the Rebeur-Paschwitz tiltmeter in 2009, which was exactly 100 years after Shida first brought it to Kyoto in 1909. Displaying the instrument during the following few months added to the recognition and celebrations of the 100<sup>th</sup> anniversary of geophysics at Kyoto University.

Learning about the Shida number as a student, gazing at the portrait of Shida during faculty meetings and finding the tiltmeter he used to observe the Earth tides at Kamigamo Observatory are all well remembered events in my memory. Even though the research of Prof. Toshi Shida is different from my field of seismology, somehow I feel that that his work 100 years ago still had an influence on my own research and experiences at Kyoto University.

For more information about Prof. Shida and the Rebeur-Paschwitz tiltmeter, see 竹本、Mori、Rivera、Frechet, 京都・上賀茂観測所で使用されたレボイル・パシュウイツ式傾斜計の変遷, 地震 63, 45-55, 2010.