John Ross Mackay - Devoted tutor and best friend of Chinese permafrost research

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ABSTRACT

The scientific accomplishments of Mackay were of great benefit to China, especially his research on ground ice. Permafrost studies began in China in the 1960s. They were mainly concerned with the impact of near-surface layers of ground ice upon engineering infrastructure. However, Chinese geocryologists had little knowledge of ground-ice genesis and massive ground ice bodies. After 1982, under the influence and generous help of Mackay, Chinese research on permafrost and ground ice became increasingly sophisticated. Mackay was respected and admired not only for his outstanding accomplishments in scientific research, but also for his devotion to science and his innovative methods for permafrost research. His family ties with China were deep.

RESUMÉ

Les contributions scientifiques de Mackay furent bénéfiques pour la Chine, en particulier ses recherche sur la glace de sol. Les études sur le pergélisol ont débuté en Chine au cours des années 1960. Elles concernaient principalement l'impact de la présence de glace de sol sur les ouvrages de génie civil et les infrastructures. À ce moment, les géocryologues chinois avaient des connaissances limitées en matière de formation de la glace dans le sol et de corps de glace massive. Après 1982, sous l'influence et l'aide généreuse de Mackay la recherche chinoise sur le pergélisol et la glace de sol est devenue de plus en plus élaborée. Mackay était respecté et admiré non seulement pour ses réalisations exceptionnelles en recherche, mais aussi pour son engagement scientifique et ses méthodes innovatrices. Ses liens familiaux avec la Chine étaient profonds.

1 INTRODUCTION

In 1982, Guodong Cheng wrote a paper in Chinese with the title "Formation processes of the thick-layered ground ice". Subsequently, he became aware that several papers had been written by Mackay over a decade earlier (Mackay, 1972) in which this ice was called "aggradational ice" and that it was syngenetic in nature. Upon learning of this, Guodong Cheng painstakingly translated his own paper into English and sent it to Mackay for advice and improvement. At that time, most Chinese geocryologists had studied only Russian in school and his clumsy English was self-taught, hence his translation was difficult to understand. However, Mackay meticulously and patiently revised the paper, almost word by word, and recommended that it be published in the journal Cold Regions Science and Technology. This paper became the first major paper published by Cheng in an international English journal (Cheng, 1983). It was also the first English-language paper on permafrost in China that was published abroad in a major technical journal. This was an inspiring event not only for Guodong Cheng but also for many of his colleagues in China in the early 1980s.

At the invitation of the Lanzhou Institute of Glaciology and Geocryology (LIGG), Chinese Academy of Sciences (CAS), Professor Mackay visited China in late October-early November, 1982. In Lanzhou, Mackay delivered six lectures on permafrost: 1) Field experiments on permafrost aggradation; 2) The growth of ice-wedge polygons; 3) The growth of pingos; 4) The genesis of massive ice; 5) The active layer and 6) Periglacial phenomena. Attendees included scholars and students from LIGG, Lanzhou University and the Northwest Institute of Railway Science. Mackay was also invited to present lectures at the Department of Geology and Geography, Lanzhou University. Afterwards, he visited the Tianshan Glaciological Station and inspected permafrost in the Tianshan Mountains (Figure 1).

Figure 1. Mackay in the Tianshan Mountains in 1982 during his visit to the Tianshan Glaciological Station, CAS, near Urumqi, Xinjiang Uygur Autonomous Region, Northwest China

2 MACKAY AND MASSIVE GROUND ICE IN CHINA

In 1987, Guodong Cheng wrote a letter to Mackay informing him that the southernmost ice wedge in the northern hemisphere had been discovered at Yituli'he ($50^{o}32'$N, $121^{o}29'$E; elevation at 730 m a. s. l.) in northern Da Xing'anling Mountains, Northeast China. This was soon reported in the Chinese Journal of Glaciology and Geocryology (Jia et al, 1987). The top of the wedge ice was at the same depth as the permafrost table (0.9 m), and the upper width of the ice wedge was about 1 m and the height of the wedge was 1.5 m (Figure 2).

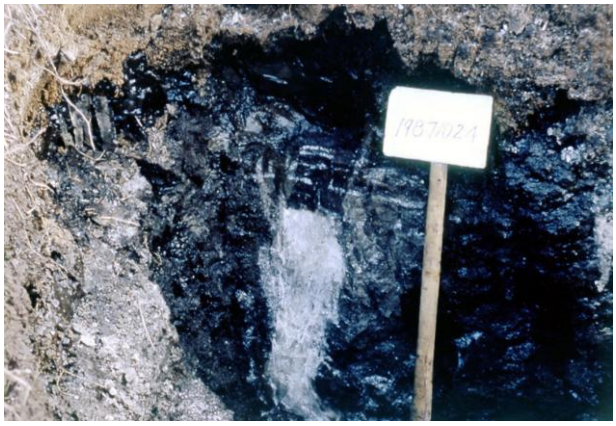

Figure 2. Inactive ice wedge at Yutuli'he in northern Da Xing'anling Mountains, Northeast China

The ground surface showed a polygonal pattern to the ice wedges. In reply, Mackay pointedly asked whether the ice wedge was still active (personal communication to Cheng, 1987). Later, in 1993, Chinese scientists discovered additional well-preserved ice wedges at Wuma ($52^{o}45'$N, $120^{o}45'$E; elevation at 700 m a. s. l.) in northwestern Da Xing'anling Mountains. As Mackay had suspected, radiocarbon dating indicated the wedges formed between 14-10 ka BP, at the end of the Late Pleistocene (Tong, 1993). Subsequently, more detailed investigations confirm that the ice wedges at both Yituli'he and Wuma were much younger.

Using research pioneered by Mackay (1983), stable oxygen and hydrogen isotopes allowed inferences at to the paleo-temperature changes, particularly the mean annual air temperatures and mean monthly air temperatures in the coldest month, when the ice-wedge ice was being formed (Yang et al., 2015). On the basis of new ^{14}C-dating and the analysis of the oxygen and hydrogen isotopes of the Yituli'he wedge ice, three short-term cooling events were inferred, with the peak of their cooling at about 2800, 2300 and 1900 a BP, and with amplitudes of cooling of about 2.1, 1.1 and 1.3°C, respectively, when compared with the present (Yang and Jin, 2011; Yang et al., 2015). In other words, these ice wedges, formed during the Neoglacial period (between 3300 and 1600 a BP), supported the earlier, highly cautious, interpretation of Mackay in 1987.

3 MACKAY'S SCIENTIFIC METHOD

Mackay had an unquenchable curiosity and desire for learning about natural phenomena and revealing the mysteries of nature. Taking the harsh Arctic as his lab, he devoted his life and passion to permafrost research. As a visiting scholar at UBC in 1984-1985, Professor Zhijiu Cui recalls (personal communication to Cheng, 2015) that, he feel very fortunate and honored being able to study permafrost and periglacial phenomena under the guidance of Mackay. He remembers that, whenever learning of some important viewpoints on the formation processes of permafrost, Mackay would conduct corresponding field experiments for either their verification or dismissal. All of the papers published by Mackay were based on personal observations and/or the results of his experiments. They were well founded and innovative.

Even during the 30 years after his formal retirement from UBC in 1981, Mackay continued his work in the Arctic each year, publishing more than 50 high-quality technical papers on the basis of his meticulous work. In 1988, Mackay came to the Fifth International Conference on Permafrost directly from the field, and directly returned to the field immediately after the Conference. Some said that the Arctic was the Paradise of Mackay. His dogged pursuit of science even in the harshest of environments has been a great inspiration to us, the Chinese geocryologists who have conducted permafrost research on the extreme high-elevation Qinghai-Tibet Plateau for several decades.

Mackay had a talent for finding ways to create and/or design simple but effective instrumentation, and he never felt bored per se. Once he told Guodong Cheng, with excitement, that "I have devised a simple probe with which I can detect small vertical changes (e.g. 0.5 mm) using small magnets buried in the ground. Now, I am able

to detect heave in frozen ground in the thaw period" (personal communication to Cheng from Mackay, 1986). Professor Zhijiu Cui also recalls impressions from 1984-85: "There was a log cabin with a kitchen at his field station on Garry Island. It took two attempts by the helicopter to find it because of very thick snow cover. After our arrival, we dug a snow pit about 1 m in depth. Then, the observation devices and instruments that Mackay had buried the previous year revealed themselves. He then erected two tele-sensors with electric currents in the extending direction of the polygonal frost crack on each side of the crack. The sensors were directly connected to a recording device. When the crack extended forward, the electrode copper wire would disconnect. The device would then record the exact time, to the hour, minute and seconds, and the date of the break. These devices were based on his formulation and were made by professional engineers, and thus unique in the world" (personal communication to Cheng from Professor Zhijiu Cui, 2015).

It was because of these unique instruments and devices that Mackay was able to decipher the secret codes of permafrost science that eluded most other people. Many of Mackay's experimental designs were creative and innovative. In particular, his full-scale experiment on permafrost growth by the draining of a tundra lake ('the Illisarvik experiment') has been one of a kind. Continuously and for many decades, he relentlessly observed and studied the processes associated with permafrost formation and pingo growth in the Mackenzie Delta region, indelibly contributing to geocryology in an impeccable way.

Professor Zhijiu Cui emotionally recalls "There were many Chinese visiting scholars abroad. However, I was extremely lucky that I could learn many new thoughts and methods from Ross. Later, I and my students deployed many observational sites in the Tianshan Mountains in West China, in the Andes Mountains, at the Great Wall Station in Antarctica, on the Qinghai-Tibet Plateau, and in the Changbai Mountains in Northeast China, … We were able to accomplish prolifically on the basis of those large amount of observational data…" (personal communications to Cheng from Professor Zhijiu Cui, 2015).

It was his large amount of long-term field experiments, innovative experimental designs, and analytical interpretations for process mechanisms that were the foundations for Mackay becoming the international guru on permafrost and ground-ice research.

4 MACKAY AND APPLIED RESEARCH IN CHINA

Mackay focused upon the basic and theoretical aspects of perennially-frozen ground. However, with increasing discoveries of petroleum and natural gas reserves in arctic regions, people suddenly needed to learn more about permafrost and ground ice. As a result, Mackay's academic research immediately became applied research, with great economic and environmental benefits.

Chinese scientists and scholars felt the same way. Studies on permafrost distribution had demonstrated that local factors, such as peatlands, ice caves, and talus deposits can effectively "cool" the ground. Thus, in the design and construction of the Qinghai-Tibet Railway from Golmud, Qinghai Province, to Lhasa, Tibet Autonomous Region, "roadbed cooling" became an extremely "hot", or popular, research topic in China. The academic aspects of permafrost cooling were quickly and conveniently applied to the use of blocky roadway materials, the use of shades and awnings, and the installation of air-ducts, with remarkable success in engineering construction and ecological benefits. Therefore, the division between theoretical and applied research seems overly simplified (Cheng, 2004).

5 MACKAY AND THE INTERNATIONAL PERMAFROST ASSOCIATION

In 1982, the late Professor Shi Yafeng, the founding father of glaciology in China, met Mackay in Lanzhou (Figure 3). After this historical meeting, Professor Shi attended the Fourth International Conference on Permafrost, held in Fairbanks, Alaska, in 1983. At this conference, that "Big Four" (the Union of Soviet Socialist Republics (USSR), Canada, the People's Republic of China (PRC) and the United States of America (USA)) created the International Permafrost Association (IPA). This was a shared initiative and Mackay was asked to become its first Secretary-General. In 1993, after serving 10 years in that office, Mackay stepped down and was greatly honored (Figure 4). Under Mackay's early guidance at the IPA, China's involvement in international permafrost studies increased rapidly in the following years (Figure 5).

Figure 3. A centennial toasting between the founding father of glaciology in China (Academician Yafeng Shi) and the founding father of geocryology in Canada (Professor Ross Mackay), in Lanzhou, Gansu Province, China, in 1982

Figure 4. A special salute and gift to Mackay was delivered by incoming IPA President Guodong Cheng at the Sixth International Conference on Permafrost, held in Beijing, China, in 1993

Figure 5. In 1998, at the Seventh International Conference on Permafrost, held in Yellowknife, NWT, Canada, the President of the IPA, Guodong Cheng, paid tribute to three pioneering geocryologists. At the podium: Academician Guodong Cheng. Standing (left to right): Professors T. L. Péwé, J. R. Mackay, and A. L. Washburn)

6 MACKAY, CHINA AND FAMILY TIES

Mackay's help to China was multifaceted. For example, in order to facilitate permafrost research in China, Professor Ross Mackay and Professor Olav Slaymaker, then Head of the Department of Geography at the University of British Columbia, actively assisted China in applying for funding from the International Development Research Centre (IDRC) under the theme of "Sino-Canada Joint Research on Permafrost, Ground Ice and Alpine Geomorphic Processes in the Kunlun Mountains, China". Although the application was unsuccessful, China will never forget the good will and generous efforts of Professors Mackay and Slaymaker.

Mackay served as an honorary professor of the LIGG, CAS, and was an honorary member of the Branch of Glaciology and Geocryology, Geographical Society of China. He volunteered to reviewing and editing English abstracts for the Journal of Glaciology and Geocryology (in Chinese), and provided constructive advice which greatly increased the international impact of the journal. He also suggested that the Qinghai-Tibet Highway and Tianshan Glaciological Station be listed as field trips for the post-conference field excursions of the Sixth International Conference on Permafrost in Beijing in 1993. These greatly added to the success of the Conference.

In Taibei (Taipei), Southeast China, there is a well-known Mackay Memorial Hospital. This is named after Mackay's grandfather who was a missionary. Although not as famous as Dr. Norman Bethune (who served in China during the WWII and almost known to everyone in China), Grandfather Mackay made great contributions to Taiwan. As a missionary, Grandfather Mackay came to Taiwan in 1872, and married Miss Cunming Zhang (Acun), a local Chinese girl, the grandmother of JRM, in 1878. The father of JRM was born in Taiwan but completed his schooling in Canada only to return to Taiwan, again as a missionary, and devoted himself to the education of children. J. R. Mackay was born at Danshui, Taiwan, in 1915 and spent his childhood there. Ross was honored with an honorary citizen of Danshui town in 2001. Danjiang Middle (High) School decided to erect a monument for J. R. Mackay at the Mackay Cemetery (Lin, 2014).

Perhaps it is because of his Chinese blood that Ross Mackay felt a close kinship to Chinese colleagues and to China. Dr. Baolai Wang recalled that Mackay once confided in him that he preferred Chinese cuisine. Professor Zhijiu Cui also has a related memory: "In winter 1984, we went to work in the Canadian arctic. It was decided that we should have a Chinese dinner. Ross ushered us to the supermarket, and he set a rule that I (Cui) should prepare the Chinese food for dinner and he (Ross) would prepare breakfast and a lunch sandwich… Possibly, and because of my satisfactory Chinese cooking, he invited me to prepare a Chinese dinner for his wife and daughter in his home upon our return to Vancouver, and with pleasure I accepted the invitation…The more interesting was, he had overheard the songs of Miss Lijun Deng (Theresa Teng) that I was listening to during our field work. He requested that I buy some cassettes (albums then) of her songs upon my return to Vancouver" (personal communications with Cheng from Professor Zhijiu Cui, 2015). Miss Theresa Teng was very popular at the time and was widely known in China. It is our belief that Ross understood and appreciated his Chinese heritage and feelings in Teng's songs.

At age 95, Mackay sent me (Guodong Cheng) a Christmas card, adding, "I look back, with great pleasure, to my trip to China." We can deeply feel Mackay's missing of China during his senior years. We also deeply miss him and will always cherish his sincere friendship and generous help.

Mackay was not only the best tutor of Chinese permafrost scholars, but also a devoted friend to us.

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