A review of China's geological and geophysical research in Antarctica over three decades

A workshop was held in May 2017 at the Institute of Geomechanics, Chinese Academy of Geological Sciences, Beijing to review the contribution of the Chinese National Antarctic Research Expedition (CHINARE) over 30 years. This was attended by 11 scientists, and the papers presented have resulted in this special issue of *Advances in Polar Science* (APS) entitled "Advances in Antarctic geoscience based on Chinese research". This thematic issue of APS brings together a selection of papers from attendees at the workshop, along with two related papers reviewing advances in China's Antarctic meteorite survey and research (Miao et al., 2018, this issue), and Antarctic geodetic remote sensing (E et al., 2018, this issue). Another two solicited papers will be presented in subsequent issues of APS. China's geological and geophysical survey and research in Antarctica over three decades is briefly reviewed below.

The earliest Chinese Antarctic geoscientists, including Zhang Qingsong, Li Huamei and Chen Tingyu, undertook research in the Vestfold Hills, from the Australian Davis Station, and in the Dry Valley (Taylor Valley) of the Trans-Antarctic Mountains, from the New Zealand Scott Station, and published their original research papers in Chinese (Chen, 1986; Zhang, 1985). Systematic geological and geophysical investigation and research in Antarctica by CHINARE started in 1984. In February 1985, China established its first Antarctic research station, the Great Wall Station on the Fildes Peninsula, King George Island, West Antarctica and geo-scientific investigation then developed more comprehensively. Since then, Chinese geologists, Liu Xiaohan, Li Zhaonai, Zheng Xiangshen, Shen Yanbin and others have conducted geological surveys and gained a comprehensive understanding of the geology and the stratigraphic sequence of the Fildes Peninsula, published in several English papers (*e.g*. Li and Liu, 1991). The stratigraphic sequence is from the Late Cretaceous to Early Oligocene. Volcanic activities could also have lasted until the Miocene. Later, Chinese geologists carried out geological surveys of the nearby Barton Peninsula and resurveyed the Fildes Peninsula, confirming that the volcanic strata there were mainly from the Paleocene to the Eocene (Gao et al., 2018; Wang et al., 2009).

In February 1989, the Chinese Antarctic Zhongshan Station was established in the Larsemann Hills, East Antarctica. Chinese geologists, Li Jiliang, Zhao Yue, Liu Xiaohan, Ren Liudong, Tong Laixi, Wang Yanbin, Yao Yupeng, Liu Xiaochun, Chen Xuanhua, Hu Jianmin, Zhang Shuanhong, Wang Wei, and others have since carried out investigation and research in this region, resulting in new findings and achievements. Zhao et al. (1993, 1992, 1991) proposed, based upon some preliminary evidence, the importance and geological significance of the *ca.* 500 Ma Pan-African event in the Larsemann Hills and adjacent areas. Besides the Pan-African event, Ren et al (1992) reported the possible existence of the earlier event, such as the Grenville event, which was confirmed by the data of Wang et al. (2008). The P-T path of the regional high-grade metamorphic rocks is clockwise, which could be attributed to the tectonic setting of the Pan-African collision orogeny. Special metamorphic minerals, such as sapphirine, and earlier medium pressure granulite facies were identified (Tong et al., 1996). Liu (1998) attempted to understand the earlier 1000 Ma middle pressure granulite facies metamorphism and linked it to the Grenville Orogeny. Further evidence for Pan-African tectonism and high-grade metamorphism has been reported and confirmed (Cui et al., 2018, this issue; Kelsey et al., 2008; Liu et al., 2007a, 2006; Boger et al., 2002; Harley et al., 1998; Fitzsimons, 1997; Hensen and Zhou, 1995; Shiraishi et al., 1994). It has become the internationally predominant consensus that assembly of East Antarctica and Gondwana occurred during the Pan-African age (Ren et al., 2018, this issue; Boger et al., 2002; Fitzsimons, 2000; Zhao et al., 2000). such as the Grenville event

From the 15th CHINARE in 1998/1999, Chinese geologists, Liu Xiaohan, Liu Xiaochun, Ju Yitai, Yu Liangjun, Hu Jianmin, Fang Aimin, Miao Bingkui, Huang Feixin, Wei Lijie, Chen Hong and Wang Wei carried out investigations and studies in the Grove Mountains. They confirmed that the Grove Mountains are a Pan-African terrane, an extension southward of the Pan-African Prydz belt (Liu et al., 2018, this issue; 2007a, 2006; Zhao et al., 2000). Late Neoproterozoic/Cambrian high-pressure mafic and pelitic granulites found there provided solid evidence that it was a collisional orogeny in the assembly of East Gondwana (Chen et al., 2018, this issue; Liu et al., 2009a) and it could extend further southwards to Antarctica's Gamburtsev Province. In addition, Li and Huang (2018, this issue) made a preliminary investigation of rubidium distribution in the Grove Mountains area.

During the 21st CHINARE in 2004/2005, Liu Xiaochun led a team to carry out a comprehensive investigation of the bedrock outcropped along the eastern edge of the Amery Ice Shelf and Prydz Bay, including the Vestfold Hills, the Rauer Group, the Larsemann Hills, and the McKaskle Hills. They compiled a Geological Map of the Prydz belt at 1:500,000 scale, and established the sequence of geological events and tectonic processes from the Greenville age to the Pan-African age for the region. They reached a conclusion of collision orogeny for the Prydz belt (Liu et al., 2009b,

2007b).

The Antarctic continent has the most extensive ice sheet on Earth, covering an area of about 14 x 10^6 km^2, with only 0.3 percent of the bedrock out-cropped. Understanding of Antarctic geological evolution is mainly based upon study of the bedrock geology in this *ca*. 0.3% area. Understanding subglacial geology and conducting large-scale geophysical surveys of the Antarctic interior have become important scientific activities during the past decade, especially in the 2007-2008 International Polar Year (IPY). During the 2007-2008 IPY and afterwards, Chinese geologists conducted subglacial geological research in Antarctica (Zhang et al., 2012; Liu et al., 2011; Liu et al., 2009a; Zhao et al., 2007). They revealed not only the regional geological history and the eastern Antarctic tectonic framework, but also found a Paleoarchean terrane adjacent to the Vestfold Hills and the Rauer Group, the earliest one in Antarctica (Zhao et al., 2017). Subglacial geology has become a key issue in recent geoscience projects.

During the 2007-2008 IPY, the Antarctic inland traverse detachment of the 25th CHINARE successfully established Kunlun Station at Dome A and installed six automatic seismic arrays to obtain observational data from inland Antarctica. This was a key contribution of the CHINARE participation in the Antarctica's Gamburtsev Province (AGAP) project during the 2007-2008 IPY. The seismic arrays at Dome A and at Eagle camp remained as a legacy of the 2007-2008 IPY. From analysis of a huge amount of data on natural seismic activities from these and other international arrays in the Antarctic inland, the high resolution 3-D seismic velocity structure of the crust and lithosphere of the Antarctic continent have been charted (An et al., 2015). This has been most helpful for understanding the tectonics of inland Antarctica and the evolution of the Antarctic continent.

In the past 30 years Chinese geologists have published a Geological Map of Antarctica at 1: 5,000,000 scale with accompanying note (Chen et al., 1995) and a monograph on the Geological Development of Antarctica and Evolution of Gondwanaland (Chen et al., 2008).

Guest Editors:
Zhao Yue, Liu Xiaochun, Ren Liudong, Liu Xiaohan

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