Some technological developments in high temperature generation using KMA and precise melting/phase relations of minerals and rocks under deep mantle conditions

*Tetsuo Irifune¹,², Youmo Zhou¹, Takeshi Arimoto³, Hideharu Kuwahara¹, Ryuichi Nomura³, Masayuki Nishi¹, Momoko Yamaguchi¹, Yoshinori Tange⁴, Takahiro Kuribayashi⁵, Zhaodong Liu⁶

1. Geodynamics Research Center, Ehime University, 2. Earth Life Science Institute, Tokyo Institute of Technology, 3. Hakubi Center/Graduate School of Human and Environmental Studies, Kyoto University, 4. Research & Utilization Division, Japan Synchrotron Research Institute, 5. Graduate School of Science, Tohoku University, 6. Institute of Super Hard Materials, Jilin University

Technological developments in stable and homogeneous high temperature generation have been made using conventional LaCrO₃ or Re heater for Kawai-type multianvil apparatus (KMA) with tungsten carbide (WC) and sintered diamond (SD) anvils. For WC-KMA, stable temperature generation to ~3000 K has been achieved under the pressures up to ~27 GPa mainly for quench experiments. Temperatures of ~2000-2300 K have been produced stably for 20-180 minutes at pressures to ~65 GPa for in situ X-ray measurements using SD-KMA, in addition to the ex situ experiments.

Some experimental studies for precise determination of subsolidus and melting phase relations have successfully been made for some simple mineral systems, such as MgSiO₃-Al₂O₃, MgSiO₃-FeSiO₃, MgSiO₃-CaSiO₃, CaSiO₃-SiO₂, Al₂O₃-SiO₂, KAlSi₃O₈-NaAlSi₃O₈, Al₂SiO₅, Ca₃Al₂Si₃O₁₂, etc. at temperatures near and above the typical geotherm at pressures corresponding to those of the mantle transition region to the middle part of the lower mantle. These studies have provided firm experimental databases for the mineralogy of the deep mantle, and also led to findings of some new high-pressure phases stable only under the very high-temperature conditions. Melting and associated partitioning of some key trace elements in more complex chemical compositions have also been conducted under the pressures of the uppermost lower mantle to constrain the differentiation and evolution of the deep mantle.

Keywords: lower mantle, multianvil apparatus, melting relations, phase relations, high pressure and high temperature experiment, technological development