COORDINATING COMMITTEE FOR GEOSCIENCE PROGRAMMES IN EAST AND SOUTHEAST ASIA (CCOP)

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Cooperating Country Report of CANADA

Submitted by

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(For Agenda Item 4)

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ANNUAL COOPERATING COUNTRY REPORT

Country:	CANADA	Period:	1 July 2017 – 30 June 2018

1. Summary

In the area of geological hazards, the Geological Survey of Canada collaborates with China, Japan and Korea, supporting the CCOP strategic goals of Cooperation and Partnership, and Knowledge Enhancement and Sharing. The collaborative projects described below have resulted in an improved understanding of geological hazards, technology transfer, capacity building and ongoing knowledge development to support natural hazard risk reduction.

2. Review of current technical activities and geoscience programmes in the CCOP Region (Multilateral or Bilateral)

Japan - Collaboration on comparative studies of subduction zones between the Geological Survey of Canada and the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) and the Research Institute of Earthquake and Volcano Geology (IEVG) of the National Institute of Advanced Industrial Science and Technology of Japan (AIST). There are many commonalities between the Nankai and Cascadia subduction zones, and these are being further investigated through cooperation in hydrologic and geodynamic studies at borehole observatories and through research on the seismicity and structure of both subduction zones. These studies seek to further refine our understanding of the fundamental tectonic processes that generate large earthquakes.
In this reporting period, the GSC built pressure monitoring systems for JAMSTEC for the Hikurangi subduction zone slow slip monitoring. Two are in the ground (CORKs for borehole pressure/strain monitoring); the two others (seafloor pressure, tilt, and temperature) will be installed in February 2019. In addition, there was ongoing processing of geophysical data from previous marine expeditions, and journal articles were published in Nature Communications and Geosphere on subduction zone related research with JAMSTEC and GSC authors.
An implementing arrangement was signed between the Geological Survey of Canada and the AIST for collaborative paleotsunami studies.

Korea - The Geological Survey of Canada and the Korea Polar Research Institute have ongoing collaboration in submarine geohazard research and have conducted collaborative offshore research on the KOPRI icebreaker, RV Aaron, in Canada's Beaufort Sea. The goal of the research is to better understand the geological processes and hazards related to degrading permafrost and gas hydrates. In this reporting period there was ongoing interpretation of results from Araon expeditions, and a cruise report from the 2017 expedition was published.

China - Collaboration on earthquake seismology between the Geological Survey of Canada and the China Earthquake Administration to examine crustal deformation associated with recent large earthquakes in China. Through comparative studies between China and eastern Canada, lessons learned in the two countries will be used to provide advice on the next generation of seismic hazard maps in China and Canada as scientific input for the building codes of both countries.
In addition, the Geological Survey of Canada has worked with the Chinese Geological Survey (CGS) to undertake collaborative studies in real time landslide monitoring. The agencies are cooperating on the monitoring of a landslide in Canada, using Chinese fibre-optic technology and Canadian remote sensing technology, with the goal of benefiting both countries in their understanding of landslide processes. The CGS and GSC signed a new MOU in 2017 for further cooperation and have been pursuing collaboration in the following areas:

- Contrastive study of continental basin sandstone-type uranium metallogenic conditions between Canada and north China: A research activity to update the deposit model of unconformity related deposits in the Athabasca Basin, determine the source of metals, and transport mechanism to identify their roles in enhancing the high grade in the Athabasca Basin (GSC Ottawa).
- The development of geochemical tools to refine a Uranium exploration model in continental basin mineralization settings. The proposal would enhance and refine geochemical methods in support of Uranium exploration and system fertility assessment (GSC Ottawa).
- Risk Assessment of Large-scale Landslide and Management of landslide mass: The delivery of a series of structured short courses under the umbrella of the International Consortium of Landslides (ICL) at key locations in China to CGS staff with short field excursion over the period of two years (GSC Pacific).
- Unconventional and Frontier Petroleum Resources Characterization and Assessment and the Related Environmental Issues/Solutions: collaboration on numerical modelling and laboratory research in the Organic Geochemistry and Petrology Laboratory (GSC Calgary) for the characterization of shale and tight hydrocarbon reservoirs using geological samples from Sichuan China and western Canada.

A GSC emeritus scientist is working with a Canadian academic and the Institute of Geology of the Chinese Academy of Geological Sciences to offer a workshop and field trip as part of the IUGS IGCP-Project 662 “Orogenic Architecture and Crustal Growth from Accretion to Collision”, a new project in the International Geosciences Program (2018-2022) sponsored by UNESCO and IUGS. The project will conduct comparative studies on the Central Asian Orogenic Belt (CAOB), the world’s largest Phanerozoic accretionary orogen, and the Tethyn orogenic belt, the world’s youngest extensive collisional and metallogenic belt, as well as other relevant orogens. The workshop will build capacity in field mapping in these areas.

3. Proposed future activities and assistance to CCOP in support to current and future activities

Korea - 2019 KOPRI RV Araon expedition to Canadian Arctic.

China - Ongoing collaboration to 2020 on landslide monitoring technologies, and collaboration on IUGS IGCP-Project 662.
Future collaboration is being considered with CGS on :

- Continued sharing of geochemistry laboratory techniques and protocols, expanding protocols for samples from different geological settings and targeting different minerals (e.g. cooper, lead, zinc, rare earth elements, etc.)

o Smart mapping technique development, specifically the development of mapping best practices and linking analytical geochemistry and geochronology to mapping protocols.

o Continued dialogue on personnel exchange for the purposes of knowledge sharing in the areas of shale gas resource characterization, frontier petroleum resources and uranium ore genesis modeling

Japan – Subduction zone and paleotsunami collaborative investigations ongoing.

4. Reports/publications of technical activities for dissemination to CCOP Member Countries

All publications of the Geological Survey of Canada are searchable at www.geoscan.nrcan.gc.ca. Relevant publications include:

Araki, E., Saffer, D.M.., Kopf, A. J., Wallace, L.M., Kimura, T., Machida, Y., Ide, S., Davis, E., and IODP Expedition 365 shipboard scientists, Recurring and triggered slow slip events near the trench at the Nankai Trough subduction megathrust, Science, 356, 1157-1160, 2017.

Cleven, N R; Lin, S; Xiao, W; Davis, D W; Davis, B; Successive arc accretion in the southern Central Asian orogenic belt, NW China: Evidence from two Paleozoic arcs with offset magmatic periods; Geological Society of America Bulletin vol. 130, 04-Mar, 2018 p. 537-557, https://doi.org/10.1130/B31434.1

Huntley, D; Bobrowsky, P; Zhang, Q; Zhang, X; Lv, Z; Fibre Bragg grating and Brillouin optical time domain reflectometry monitoring manual for the Ripley Landslide, near Ashcroft, British Columbia; Geological Survey of Canada, Open File 8258, 2017, 66 pages, https://doi.org/10.4095/304235

Kinoshita, C., Saffer, D., Kopf, A., Roesner, A., Wallace, L., Araki, E., Kimura, T., Machida, Y., Kobayashi, R., Davis, E., Toczko, S., Carr, S., and Expedition 365 Scientists. Changes in physical properties of the Nankai Trough megasplay fault induced by earthquakes, detected by continuous pressure monitoring, Journal of Geophysical Research, doi: 10.1002/2017JB014924, 2018.

Jin, Y K (ed.); Côté, M M (ed.); Paull, C K (ed.); King, E L (ed.). 2017 Korea-Canada-U.S.A. Beaufort Sea (offshore Yukon and Northwest Territories) research program: 2017 Araon expedition (ARA08C) cruise report; Geological Survey of Canada, Open File 8406, 2018, 206 pages, https://doi.org/10.4095/308396

Tonegawa, T; Obana, K; Yamamoto, Y; Kodaira, K; Wang, K; Riedel, M; Kao, H; Spence, G C. Fracture alignments in marine sediments off Vancouver Island from Ps splitting analysis; Bulletin of the Seismological Society of America vol. 107, no. 1, 2017 p. 387-402, https://doi.org/10.1785/0120160090 (ESS Cont.# 20160105)

Sun, T; Wang, K; Fujiwara, T; Kodaira, S; He, J. Large fault slip peaking at trench in the 2011 Tohoku-oki earthquake; Nature Communications vol. 8, (2017), ; 14044, 2017, https://doi.org/10.1038/ncomms14044 (ESS Cont.# 20160230)

Wada, I; He, J. Thermal structure of the Kanto region, Japan;

Geophysical Research Letters vol. 44, 14, 2017 p. 7194-7202, https://doi.org/10.1002/2017GL073597

Wang, K; Sun, T; Brown, L; Hino, R; Tomita, F; Kido, M; Iinuma, T; Kodaira, S; Fujiwara, T. Learning from crustal deformation associated with the M9 2011 Tohoku-oki earthquake; in, Subduction top to bottom 2; Bebout, G E (ed.); Scholl, D W (ed.); Stern, R J (ed.); Wallace, L M (ed.); Agard, P (ed.); Geosphere vol. 14, no. 2, 2018 p. 552-571, https://doi.org/10.1130/GES01531.1 (NRCan Cont.# 20170258)