The ~820 Ma Mafic Rocks at the Olympic Dam Iron Oxide Cu-U-Au Deposit: An Alteration Analysis

Qiuyue Huang,[1*] Vadim S. Kamenetsky,[1] Jocelyn McPhie,[1] Kathy Ehrig,[2] Sebastien Meffre,[1] Roland Mass,[3] Olga Apukhtina,[1] Maya Kamenetsky,[1] and Isabelle Chambefort[1,4]

[1]ARC Centre of Excellence in Ore Deposits (CODES), School of Physical Sciences, University of Tasmania, Private Bag 79, Hobart, Tasmania, Australia 7001
[2]Australia BHP Billiton Olympic Dam, Adelaide, SA 5000, Australia
[3]School of Earth Sciences, University of Melbourne, VIC 3010, Australia
[4]GNS Science, Wairakei Research Centre, Taupo 3377, New Zealand

*E-mail, zerozoomhuang@gmail.com

The Olympic Dam (OD) iron oxide copper-gold (IOCG)-uranium-silver deposit, South Australia, contains the world's largest published uranium, fifth largest copper, and third largest gold resource (9,576 Mt at 0.82 % Cu, 0.26 kg/t U_3O_8, 0.31 g/t Au, 1.39 g/t Ag). It was discovered by Western Mining Corporation, based on a sediment-hosted copper deposit model in 1975, and was considered a new type of strata-bound sediment-hosted ore deposit when it was first reported in literature. Later, the OD deposit and other iron ore deposits (e.g., the Kiruna deposit, Sweden) were grouped to constitute the IOCG type deposits. According to the most recent model, the IOCG (sensu stricto) deposits (including the OD deposit) are magmatic-hydrothermal deposits involving variable degrees of mixing of magmatic fluids, derived from devolatization of mantle-derived magmas, with other crustal fluids. Recent research on the OD deposit has revealed the potential role of a sedimentary basin and sedimentary process in its ore genesis.

Regardless of various models proposed for the OD deposit, mafic rocks at OD have always been considered important sources for copper. Generally, there are two major groups of mafic lithologies present at OD: the first group is correlated with the ~1600 Ma Gawler Range Volcanics (GRV), consisting of mainly olivine-rich lavas and dikes, and possibly olivine-absent plagioclase-abundant mafic dikes; the second group comprises basaltic to dominantly doleritic dikes, belonging to the ~820 Ma Gairdner dike swarm in the Gawler Craton. Rocks from the first group have invariably been intensely altered; there are no fresh equivalents discovered at OD and in its adjacent area. In contrast, younger dikes from the second group show a wider range of alteration intensity, and both relatively fresh and intensely altered equivalents have been recovered by drilling. This provides us with an opportunity to examine the alteration process associated with this younger suite of dikes.

Internal compositional comparisons between the least- and intensely altered dolerite dikes at OD, as well as external comparisons of the OD dolerite with the Gairdner Dike Swarm in the Gawler Craton and other typical dolerite dikes worldwide (e.g., Karoo, Deccan, and Tasmania dolerite), have been carried out, showing elemental mobilization in the OD dolerite during hydrothermal alteration. What emerges is that OD dolerite is generally depleted in copper. The copper depletion is associated with sodic alteration, as indicated by elevated Na_2O/CaO ratios. This is also in accordance with petrographical observation that plagioclase is rimmed and/or replaced by a tiny amount of albite in these dolerite dikes.