The distribution of the Central Iapetus Magmatic Province (CIMP) into West African craton: U-Pb dating, geochemistry and petrology of Douar Eç-çour and Imiter mafic Dyke Swarms (High and Anti-Atlas, Morocco)

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The 615-540 Ma Central Iapetus Magmatic Province (CIMP) was emplaced in multiple pulses during Ediacaran-Cambrian times, and has been linked to the disruption of the Rodinia supercontinent leading to the opening of the Central Iapetus Ocean. It is well represented in Laurentia and Baltica but also present on other formerly attached blocks such as the Congo Craton, the West African Craton (WAC) and Amazonia. In northwest Africa (Morocco), the CIMP occurrences are found particularly in the High and Anti-Atlas of Morocco, as the 600-541 volcano-sedimentary sequences of the Ouarzazate Supergroup (i.e. "XIII" or PIII of Choubert et al., 1963) that covered ca. 2 x 10^6 km^2 with an estimated magma volume of ca. 1 x 10^6 km^3 and volcanic thicknesses greater than 3000 m. It also occurs as dyke swarms and sill complexes that are the plumbing systems of the Ouarzazate Large Igneous Province. Two CIMP related Ediacaran dolerite dyke swarms cut the Precambrian basement of the Ouzellagh promontory in the High Atlas and the Jebel Saghro massif in the Anti-Atlas: 1) the NNE, NE to ENE-trending Douar Eç-çour mafic dyke swarm and 2) the NE-trending Imiter swarm. The Douar Eç-çour dykes have an approximate zircon/apatite/rutile U-Pb dating age as 554 ± 6 Ma. These Imiter dykes show co-mingling magmatic textures with the Askaoun granodiorite of the Assarag suite dated at 579± 7 Ma (U-Pb zircon, Chevalier et al., 2001).The Imiter dykes yield a crystallization age of 578.8 ± 3.8 Ma (MSWD C+E = 1.3, n = 31; upper intercept age 581 ± 10 Ma; MSWD = 0.83) and have geochemical characteristics of continental tholeiites. Possible equivalents are the continental flood basaltic (CFB) lava flows of the second eruptive cycle of the Ouarzazate Supergroup. The world-class Imiter epithermal vein silver deposits are genetically associated with 550 ± 3 Ma rhyolites, and therefore may also be linked to the CIMP event. The Imiter dyke correspond to the northern extension of the Great Foum Zguid dyke which was recently dated at 201.111 ± 0.071 Ma (U-Pb on zircon; Davies et al., 2017) near Foum Zguid town and at 208.6 ± 3.7 Ma in the Bou Azzer El Graara inlier (this work). So the Foum Zguid belongs to the 201 Ma Central Atlantic Magmatic Province (CAMP) event and is unrelated to the c. 581 Ma Imiter dyke. Geochemically, the c. 581 Ma Imiter dykes were generated in an intraplate

setting, and the c. 279-554 Ma Douar Eç-çour dykes have three compositional groups calc-alkaline, tholeiitic and alkaline. We interpret these Douar Eç-çour geochemical groups to represent three distinct pulses that are likely the plumbing system ("feeder dykes") of the Ouarzazate supergroup volcanic pile since the three dyke compositions match the three successive eruptive cycles (synextensional calc-alkaline, tholeiitic CFB and alkaline) of the Ouarzazate Supergroup. The studied dolerite dyke swarms have formed during the fragmentation of Rodina (Pannotia) leading to the opening of the Central Iapetus Ocean and therefore are compared to similar-age, rift-related extrusive/intrusive rocks found in the Siroua Window, Jebel Saghro Massif, Ougnat Inlier and other inliers of the Anti-Atlas. The dykes provide a window into the late Ediacaran mantle, and also shed light on early magmatic processes accompanying the breakup of the WAC region. Links between the CIMP and the Gaskiers glaciation and the Cambrian Bioradiation are proposed: 1) the c. 580 Ma CIMP pulse (mainly silicic) helped trigger a Volcanic Winter and subsequent Snowball Earth conditions ("Icehouse"), i.e. the Gaskiers glaciation. 2) the subsequent c. 570 Ma flood basalt CIMP pulse helped trigger a "Volcanic Summer" and succeeding global warming conditions ("Greenhouse") that ended the ice age and contributed to consequent expansion and diversification of the life on Earth, i.e. the Cambrian Bioradiation.