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An unusual occurrence of carbonatites derived from the crust in the UHT granulite facies metamorphic terrain of Sri Lanka

W.A.G.K. Wickramasinghe [a,b,c], T.B.N.S. Madugalla [d], Bhathiya Athurupana [b], Lei Zhao [e,*], Mingguo Zhai [e], Xianhua Li [e], H.M.T.G.A. Pitawala [b,c,**]

[a] Geological Survey and Mines Bureau, 569, Epitamulla Road, Pitakotte, Sri Lanka
[b] Department of Geology, University of Peradeniya, Peradeniya, Sri Lanka
[c] Postgraduate Institute of Science, University of Peradeniya, Peradeniya, Sri Lanka
[d] Faculty of Applied Sciences, South Eastern University of Sri Lanka, Sammanthurai, Sri Lanka
[e] Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, China

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ABSTRACT

The special calcite bodies (CBs) exposed within the ultrahigh temperature (UHT) granulite facies terrain in the Balangoda area of Sri Lanka preserve shreds of evidence for the generation of crust-derived carbonatite in the crust. The CBs are exclusively made up of massive calcites and appear as concordant bands extending tens of meters or as *meso*-scale isolated pockets hosting the massive dolomitic marble band. Various sizes of mafic and calc-silicate enclaves occur as rotated or tilted structures within the CBs. The contact between the CBs and the host marble is texturally and mineralogically gradational, while the contact between the enclaves and the CBs is sharp. The large-ion lithophile elements and rare earth element contents of the CBs show enrichment compared to the host marble, while depletion compared to typical carbonatites. Furthermore, the Sr content and C-O isotope values in CBs differ from those found in known carbonatites, hydrothermal carbonates, or metasomatic carbonates. We suggested that the crustal anatexis of marble should be hypothesized as the possible mechanism for the origin of the CBs. Microtexural evidence of the calcite grains shows indications of the melting of the host marble. The release of CO_2-rich fluids from the collision and thrusting of HC over VC, or related metamorphic events, likely lowered the solidus of carbonates, triggering crustal anatexis of marble during UHT granulite facies metamorphism. The generated low viscous carbonate melt may have moved rapidly, resulting in a low degree of mixing of silicates and fragmentation and dislocation of enclaves. The results of the present study reflect the existence of anatexis of carbonates under extreme crustal conditions and provide a better understanding of the sources, migration paths and reservoirs of the carbon recycling processes.

1. Introduction

The processes of generating carbonatite from the mantle, that is, the carbon cycle involving those released to the exosphere from the mantle, have been discussed in depth during the last two decades by commendable studies and reviews (Dasgupta and Hirschmann, 2010; Poli, 2015; Matthews et al., 2017; Müller and Dutkiewicz, 2018; Plank and Manning, 2019; Wong et al., 2019). On the other hand, the behaviour of carbon in crustal reservoirs and its recycling processes have not been well understood with respect to their contribution to the deep carbon cycle (Liu et al., 2015; Plank and Manning, 2019). Nonetheless, in extreme tectonic and metamorphic settings, crustal carbonate rocks may partially melt as the ambient temperature is very high, or the solidus temperature of minerals decreases due to metamorphic fluid fluxes (Scaillet and Prouteau, 2001; Santos et al., 2013; Spandler and Pirard, 2013; Gao et al., 2017; Li et al., 2020; Groppo et al., 2020, Wu et al., 2022; Martin et al., 2022).

Carbonatites, marbles, limestone and dolostones, which have originated due to magmatic, metamorphic and sedimentary processes, respectively, are common lithological carbon reservoirs in the crust (Ague, 2003; Des Marais, 2001; Halama and Bebout, 2021). Besides, calcite-rich carbonate bodies of various origins can also be seen in the

* Corresponding author.
** Corresponding author at: Department of Geology, University of Peradeniya, Peradeniya, Sri Lanka.
E-mail addresses: zhaolei@mail.iggcas.ac.cn (L. Zhao), apitawala@yahoo.com (H.M.T.G.A. Pitawala).

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