

Modelling the temperature history of mantle lithosphere using FTIR maps of diamonds

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FTIR maps of diamond plates, cut through the centre of growth, contain abundant information about changing defect concentrations from core to rim. These data can, in principle, be interpreted in terms of the variation in conditions of diamond growth and the temperatures experienced by the diamond during the period of mantle residence between growth and exhumation. Many diamonds show multiple growth zones that can be observed by cathodoluminescence. Importantly, the combination of nitrogen concentration and nitrogen aggregation measured by FTIR can be used to determine whether the growth zones are of similar or very different ages (Kohn et al., 2016).

In this study, we use automated fitting of several thousand individual spectra within each FTIR map to define a model temperature for each pixel using the Python program, QUIDDIT. We then use a two-stage aggregation model to constrain potential temperature-time histories for each diamond. To take full advantage of the temperature history recorded by zoned diamonds, radiometric ages of inclusions are required. If the growth ages of each zone and the date of exhumation are well-known, then a model temperature can be calculated for each zone.

The combination of zone-specific ages and improved quality and processing of FTIR spectra is able to provide unique new insights into the thermal history of diamond-bearing lithospheric mantle. For the first time we will be able to use the N defects in diamonds to work out whether a particular location in the lithosphere has heated or cooled over long periods of geological time. The implications for the mechanism of formation of lithosphere will be discussed.

We will illustrate the approach using examples of zoned diamonds from Murowa (Zimbabwe), Argyle (Australia), Diavik (Canada), Venetia (South Africa) and Orapa (Botswana).

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