Isotopic variations in S-type granites : an inheritance from a heterogeneous source.

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Inherited zircons from S-type granites provide exceptionally good insight into the isotopic heterogeneity of their sources. Zircons from four samples (one granite, two granodiorites, one granodioritic enclave) of Pan-African S-type granite of the Cape Granite Suite (c. 540 Ma) have been the subject of a laser LA-ICP-MS zircon U/Pb study to determine emplacement ages and inheritance. Zircons from three of these samples (2 granodiorites and 1 granodioritic enclave) were also analysed for Hf isotopes by LA-MC-ICP-MS. Ages of inherited cores range from 1200 to 570 Ma and show Hafnium isotope values (eHf,t) for the crystallisation age (t) of the different cores that range from -14.1 to +9.1. Magmatic zircons and magmatic overgrowth with concordant spot ages between ca. 525 and ca. 555 Ma show a similar range of eHf,t, between -8.6 and +1.5, while eHf values calculated at 540 Ma (eHf,540) for inherited cores ranges from -15.2 to +1.7. Thus, our results show that the time evolved eHf arrays of the inherited cores overlap closely with the eHf range displayed by the magmatic rims at the time of crystallisation of the pluton. These similarities imply a genetic relationship between magmatic and inherited zircons. Within the inherited cores four main peak ages can be identified. This, coupled to their large Hf isotopic range emphasizes that the source of the granite is highly heterogeneous. The combination of the U/Pb zircon ages ranges and Hf isotope data implies that : 1. The source of S-type granite consists of crustal material recording several regional events between 1200 and 600 Ma. This material records the recycling of a much older crust derived from depleted mantle between 1.14 and 2.02 Ga. 2. The homogenisation of Hf isotopic variation in the magma acquired through dissolution of the entrained zircon, via mechanical mixing and/or diffusion between within the granite was particularly inefficient. 3. This evidence argues for the assembly of the pluton through many relatively small magma batches that undergo rapid cooling from their intrusion temperature (ca. 850 °C) to background magma chamber temperature that is low enough to ensure that much of the magmatic zircon crystallized rapidly (>80% by 700 °C). 4. There is no evidence for the addition of mantle-derived material in the genesis of S-type Cape Granite Suite, where the most mafic granodiorites are strongly peraluminous, relatively low in CaO and K2O-rich. Interpreted more widely, these findings imply that S-type granites inherit their isotopic characteristic from the source. Source heterogeneity transfers to the granite magma via the genesis of discrete magma batches. The information documented from the S-type CGS zircons has been recorded because the individual batches of magma crystallised the bulk of their magmatic zircon prior to mechanical or diffusional magma homogenization. This is favoured by zirconium saturation in the magma shortly after emplacement, by partial dissolution of the entrained zircon fraction, as well as by the intrusion of volumetrically subordinate magma batches into a relatively cool pluton. Consequently, evidence recorded within inherited cores will most likely be best preserved in S-type granite plutons intruded at shallow depths. Other studies that have documented similar eHf arrays in magmatic zircons have interpreted these to reflect mixing between crustal- and mantle-derived magmas. This study indicates that such arrays may be wholly source inherited, reflecting mixing of a range of crustal materials of different ages and original isotopic signatures.