U-Pb zircon, sphene and apatite ages from shear zone-hosted syenites: Implications on Pb retentivity in magmatic and metamorphic sphene

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An apparently paradoxical feature of orogenic cycles is the development of major extensional structures within overall compressive systems. Sometimes, intrusion of mantle-derived magmas, are connected with these zones of weakness. Consequently, the emplacement of these magmas into the crust has become a fundamental component of petrogenetic models and it is becoming increasingly apparent that there is a spatial and temporal coincidence of plutonism with major shear zones in many orogenic belts. In the Damara orogen (Namibia) Pb-Pb zircon ages obtained on some on-shear zone and off-shear zone syenites yielded consistent ages of c. 520 Ma which are interpreted as the age of intrusion of these syenites close to the peak of regional metamorphism. Pb-Pb sphene ages obtained on xenocrystic dark brown sphenes from off-shear zone syenites yielded significantly older ages between c. 700 and 730 Ma similar to zircon and sphene ages from syenites from the northern part of the orogen. Since the c. 730 Ma age is similar to the proposed age of sedimentation of the country rock metapelites the sphene ages are not interpreted as metamorphic ages, instead the xenocrystic dark brown sphenes are likely remnants of pre-existing igneous rocks in the deeper crust. Together these ages precisely define the onset of rifting and access of mantle sources during the early stages of orogeny at c. 730 Ma. Pb-Pb sphene ages obtained on light brown sphenes which occurred as mantles around the dark brown sphenes and as individual crystals define two groups with ages between c. 610 and 575 Ma and between c. 540 and 490 Ma. The older ages are interpreted as the age of sphene growth during regional metamorphism in the southern part of the Damara orogen which is structurally unrelated to the rest of the orogen. The younger ages correspond either to another peak of regional metamorphism or to intrusion of on-shear zone syenites which yielded consistent Pb-Pb sphene and apatite ages between c. 490 and c. 550 Ma. These data indicate activity of the shear zone at c. 700 Ma (onset of rifting) and between 490 and 550 Ma (regional metamorphism). Furthermore, for the off-shear zone syenites Pb retentivity in sphene is high indicated by the inheritance of older sphene in younger intrusive rocks and by the preservation of older metamorphic sphenes. Lastly, for the on-shear zone syenites the similarity of apatite and sphene ages suggests that these ages rather represent magmatic ages then metamorphic ages implying fast cooling rates during intrusion.