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Journal of African Earth Sciences 38 (2004) 413–435
Journal of African Earth Sciences
www.elsevier.com/locate/jafrearsci

The Rössing Uranium Deposit: a product of late-kinematic localization of uraniferous granites in the Central Zone of the Damara Orogen, Namibia

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Received 18 September 2003; accepted 22 April 2004

Abstract

The Rössing granite-hosted uranium deposit in the Central Zone of the Pan-African Damara Orogen, Namibia, is situated in the "SJ area" to the south of the Rössing Dome. The coincidence of a number of features in this area suggests that mineralization is closely linked to late-kinematic evolution of the Rössing Dome. These features include: (1) the rotation of the dome's long axis (trend of 017°), relative to the regional F_3 trend of 042°; (2) southward dome impingement, concomitant with dome rotation, producing a wedge-shaped zone of alkali-leucogranites, within which uranium mineralization is transgressive with respect to granites and their host lithologies; uranium mineralization and a high fluid flux are also confined to this arcuate zone to the south and south-east of the dome core and (3) fault modeling that indicates that the SJ area underwent late-D_3 to D_4 brittle–ductile deformation, producing a dense fault network that was exploited by leucogranites. Dome rotation and southward impingement occurred after a protracted period of transtensional tectonism in the Central Zone, from ca. 542 to 526 Ma, during which I- and S-type granites were initiated in a metamorphic core complex. Late-kinematic deformation involved a rejuvenation of the stresses that acted from ca. 600 to 550 Ma. This deformation overlapped with uranium-enriched granite intrusion in the Central Zone at 510 ± 3 Ma. Such late-kinematic, north–south transpression, which persisted into the post-kinematic cooling phase until at least 478 ± 4 Ma, was synchronous with left-lateral displacement along NNE-trending ("Welwitschia Trend") shears in the vicinity of Rössing. Late-kinematic deformation, causing block rotation, overlying dome rotation and interaction of the more competent units of the Khan Formation with the Rössing Formation in the dome rim was pivotal in the localization of uranium-enriched granites within a highly fractured, high-strain zone that was also the site of prolonged/high fluid flux.

Keywords: Leucogranite; Uranium; Mineralization; Late-kinematic; Damara Orogen; Namibia

1. Introduction

Whereas diapiric upwelling is confined to the lower ductile crust, upper crustal granitic melt movement is governed by the prevailing tectonic setting, such as continental collisional orogens and active continental margins (Ramberg, 1981; Brown and Rushmer, 1997; Petford et al., 2000). Upper crustal granites and their host structures essentially reflect the influence of an applied differential stress on magmas, a process that may locally be more important than the effects of gravity (Petford et al., 2000). The scale at which granite plutons and their feeders are examined is crucial, for instance, despite regional compression or transpression, granites commonly intrude into local transtensional zones (Vigneresse, 1995a,b; Brown and Rushmer, 1997). There is limited non-experimental data on the physical and mechanical properties of magmas, consequently, direct observation of upper crustal or near-surface features should provide the basis for most granite intrusion models (Delaney et al., 1986; Bouchez et al., 1990; Hutton et al., 1990; Vigneresse, 1995a,b; Fernandez and Castro, 1999). Information on the third dimension of

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0899-5362/$ - see front matter
doi:10.1016/j.jafrearsci.2004.04.004