Journal of Structural Geology 62 (2014) 125–140

Contents lists available at ScienceDirect

Journal of Structural Geology

journal homepage: www.elsevier.com/locate/jsg

Complex vein systems as a data source in tectonics: An example from the Ugab Valley, NW Namibia

Xavier Maeder [a,*], Cees W. Passchier [a], Rudolph A.J. Trouw [b]

[a] Institut für Geowissenschaften, Johannes Gutenberg University, 55099 Mainz, Germany
[b] Instituto de Geociências, Universidade Federal do Rio de Janeiro, 21949-900 Rio de Janeiro, Brazil

ARTICLE INFO

Article history:
Received 25 July 2013
Received in revised form
28 December 2013
Accepted 13 January 2014
Available online 5 February 2014

Keywords:
Veins
Folds
Southern Kaoko Belt
Fluid overpressure

ABSTRACT

Neoproterozoic metaturbidites in the Lower Ugab Domain, Namibia, contain a complex network of four sets of quartz-calcite veins, overprinted by km-scale folds associated with four regional foliations. The veins formed by fluid overpressure predating the main deformation. Deformation structures developed at the junction of two mobile belts during the assembly of Gondwana, the NS Kaoko Belt, and the EW trending Damara Belt. Km-scale NS trending folds were initiated during EW constriction in the Kaoko Belt, while their further development and all subsequent events are related to constriction in the EW-Damara Belt, with coeval sinistral strike slip in the Kaoko Belt. Deformation of the veins, and development of four orthogonal foliations are due to gradual changes in the bulk tectonic framework rather than separate orogenic events. The veins are deformed in a complex manner allowing a full 3D reconstruction of regional sequence of events. The local complex tectonics could be reconstructed because of the perfect local exposure and the multitude of veins: it illustrates the potential complexity of tectonic events and structural evolution in apparently simple slate belts.

1. Introduction

Folding of metasediments at high fluid pressure usually induces abundant syntectonic fractures and veins (Bergbauer and Pollard, 2004; Guiton et al., 2003; Bellahsen et al., 2006), which are subsequently deformed in various stages of deformation. As such, vein networks can be very useful in unravelling a sequence of events. In this paper, we present assumingly simple folds in metaturbidites of the Lower Ugab Domain in NW Namibia (Fig. 1, Miller and Grote, 1988). These metaturbidites are particularly rich in composite quartz and calcite veins, and because of their excellent exposure, the vein systems allow the unravelling of a complex polyphase deformation history: this implies that other, less well exposed low-grade folded metapelite belts may have a similar, complex history of deformation and vein formation. A detailed structural study on the veins in the Lower Ugab Domain therefore contributes new data to the understanding of the regional tectonic evolution of the junction of the Kaoko and Damara mobile belts during the Cambrian (Schmitt et al., 2012), and to the development of early vein systems in metapelites and of folded slate belts in general.

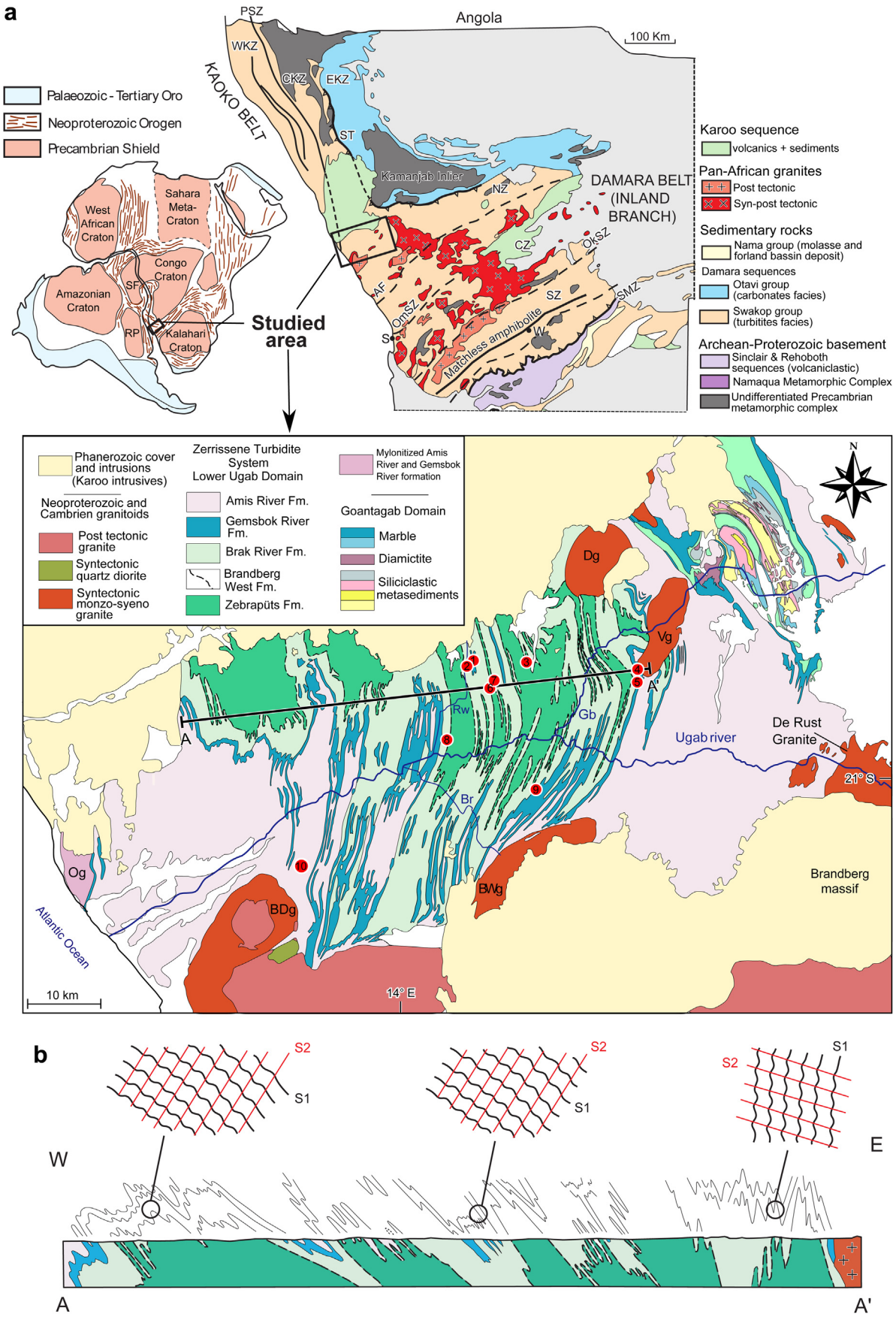
2. Geological setting and structural evolution of the Lower Ugab Domain

The Lower Ugab Domain, also called the Ugab Zone (Goscombe et al., 2003a,b), lies at the junction of the Kaoko and Damara Pan-African mobile belts in NW Namibia (Fig. 1: after Miller (1983) and Gray et al. (2008)). The Damara Belt is the ENE trending inland arm of the belt and is the collisional zone between the Angola and Kalahari cratons, (Miller, 1983; Kukla and Stanistreet, 1991; Prave, 1996). The coastal Kaoko Belt is a transpressional orogen between the Angola and the Rio de la Plata cratons (Fig. 1). It has predominantly NNW trending structures with ENE vergence, dominated by two crustal-scale sinistral shear zones, with increasing metamorphic grade from greenschist facies in the east to upper amphibolite/granulite facies in the west (Goscombe et al. 2003a, b; 2005). These shear zones extend south at least as far as the Ogden rocks on the western limit of the Lower Ugab Domain (Fig. 1). The Lower Ugab Domain is considered to be the southern zone of the Koako Belt (Miller, 1983; Miller and Grote, 1988; Hoffman et al., 1994), separated from the main part of the belt by the Etendeka plateau composed of Phanerozoic cover.

The metasediments that compose the Lower Ugab Domain are a succession of Neoproterozoic siliciclastic and interbedded carbonates and turbidites metamorphosed to middle greenschist facies,

* Corresponding author. Present address: CSEM, Centre Suisse d'Electronique et de Microtechnique, 2000 Neuchâtel, Switzerland. Tel.: +41 32 720 5107.
E-mail address: xavier.maeder@csem.ch (X. Maeder).

http://dx.doi.org/10.1016/j.jsg.2014.01.011
0191-8141/


a
Angola
100 Km
PSZ
WKZ
CKZ
EKZ
ST
KAOKO BELT
Kamanjab Inlier
DAMARA BELT
(INLAND
BRANCH)
NZ
CZ
OkSZ
AF
SZ
SMZ
OmSZ
Matchless amphibolite
S
W
Studied
area
West
African
Craton
Sahara
Meta-
Craton
Congo
Craton
SF
Amazonian
Craton
RP
Kalahari
Craton
Palaeozoic - Tertiary Oro
Neoproterozoic Orogen
Precambrian Shield
Karoo sequence
volcanics + sediments
Pan-African granites
Post tectonic
Syn-post tectonic
Sedimentary rocks
Nama group (molasse and
forland bassin deposit)
Damara sequences
Otavi group
(carbonates facies)
Swakop group
(turbitites facies)
Archean-Proterozoic basement
Sinclair & Rehoboth
sequences (volcaniclastic)
Namaqua Metamorphic Complex
Undifferentiated Precambrian
metamorphic complex
Phanerozoic cover
and intrusions
(Karoo intrusives)
Neoproterozoic and
Cambrien granitoids
Post tectonic
granite
Syntectonic
quartz diorite
Syntectonic
monzo-syeno
granite
Zerrissene Turbidite
System
Lower Ugab Domain
Amis River Fm.
Gemsbok River
Fm.
Brak River Fm.
Brandberg
West Fm.
Zebrapüts Fm.
Mylonitized Amis
River and Gemsbok
River formation
Goantagab Domain
Marble
Diamictite
Siliciclastic
metasediments
N
Dg
Vg
Rw
Gb
Br
A
A'
Ugab river
De Rust
Granite
21° S
Brandberg
massif
Og
BDg
BWg
Atlantic Ocean
10 km
14° E
b
S2
S1
W
E
A
A'