Results of field studies

Introduction

The field research was performed between June 29 and August 22, 2000. The field studies are part of my PhD project at the Department of Earth Sciences, University of Utrecht. The title of the projects is: 'Terrane Accretion in the Archaean Pilbara Craton, Western Australia: when, how, and implications for early Earth tectonics.' It is a field based project that comprises structural-kinematic analyses of domain boundary shear zones, complemented by geochronological, metamorhpic and geochemical studies. My promotor is Professor S.H. White of the Structural Geology and Tectonics group, Department of Earth Sciences, Utrecht University. My co-promotor is Dr. J.R. Wijbrans of the Isotope Geology Group, Earth Sciences, VU Amsterdam.

General motivation

The Pilbara is one of the few early- to mid-Archean areas in which terrane accretion has been identified. The kinematic and geochronological data, collected from selected domain boundaries and their adjoining intra-domainal areas, will indicate how and when accretion occurred and whether or not this is similar to accretion processes seen in modern orogens. In addition, pressure-temperature data collected from intradomainal areas will give consraints on the thermal regime. The obtained information about the direction and rates of plate motion will help to unravel the puzzle of the tectonic development of the early Earth.

Regional background

The Pilbara craton in Western Australia (figure 1) is an Archean granitoid-greenstone terrain, which typically consists of granitoid-gneiss complexes surrounded by belts of volcanic and sedimentary rocks of low metamorphic grade. The components range in age roughly from 3.6 to 2.8 Ga. Early structural models related the deformation history of the Pilbara to the diapiric emplacement of the granitoids (Hickman, 1984), but more recent studies have shown that horizontal tectonics are at least equally important.

The Pilbara Craton records Archaean continental growth as it consists of 6 different tectonostratigraphic domains. These domains were assembled 3.1 and 2.8 Ga (Smith et al., 1999) and they generally become progressively younger towards the north-west. The domains are separated by major crustal scale shear zones, which are the main subject of this study.

The Mulgandinnah Shear Zone.

The Mulgandinnah Shear Zone forms the western margin of the Shaw Batholith. Previous studies have determined that the northern section of the Mulgandinnah Shear Zone was last active at about 2950 Ma. Towards the south, the shear widens up to 7 kilometers and into the Shaw Batholith the

metamorphic grade increases significantly. This lower crustal part of the shear zone was expected to contain information about the earlier history of the structure, probably going back to 3.2 Ga or even 3.47 Ga. The field observations of the lower crustal section of the Mulgandinnah Shear Zone do not confirm the presence of an early deformational phase. It may have been completely overprinted by the 2950 Ma major sinistral event. Work on the microstructures and geochronology is in progress.

The Tabba Tabba Shear Zone

The Tabba Tabba Shear Zone has historically been appointed as the major division between the East and West Pilbara because the terranes to the west of it have no pre- 3.3 Ga history. The Warrawoona Group does not occur to the west of this shear zone, and the 3.45 and 3.3 Ga tectonic events recognized in the East Pilbara did not occur to the west of this structure.

A set of large shear zones runs parallel and to the north west of the Tabba Tabba Shear Zone, within the Pippingarra granitoid. The structures and kinematics of these zones are similar to the structures and kinematic history of the Tabba Tabba Shear Zone itself. It has been confirmed that the Tabba Tabba Shear Zone and its related structures record an early dextral phase, a major sinistral transpressive phase, and finally a minor dextral phase of deformation. Work continues on their microstructures and geochronology. The geochronological data will tie the observed deformational events of the Tabba Tabba Shear Zone in with the tectonics of the West Pilbara.

The Mallina Basin

The western margin of the Mallina Basin reveals a complex deformation history involving several phases of folding related to movement on the Sholl Shear Zone and the Loudens Fault. Structures in the eastern part of the basin are expected to be related to deformation on the Tabba Tabba Shear Zone. Multiple phases of deformation (i.e. refolded folds) have been recorded. The sediments of the Mallina Basin are metamorphosed at grades varying between low greenschist facies and amphibolite facies. Samples have been collected for a quantitative metamorphic study.

The Sholl Shear Zone

Final field checking on the Sholl Shear Zone has confirmed that initial deformation in the now steeply north dipping Sholl Shear Zone and in the hanging wall took place at amphibolite grade conditions. Kinematic analyses indicate thrusting with transport towards the SSE, followed by a dextral transcurrent phase during which deformation took place at greenschist grade conditions. There is cryptic local microstructural evidence for an early sinistral phase, but the large-scale structures do not record a major sinistral phase, which has been suggested by previous workers who only rely on stratigraphic relations and geochemistry.

Structures in the Roebourne Complex and Cleaverville area.

In the Roebourne Complex and the Cleaverville area WSW-ENE trending thrusts and fold axes indicate that both areas experienced NNW-SSE directed compression. The areas experienced low to high greenschist grade metamorphism. Work continues on microstructures, metamorphism and geochronology.

Geochemical reconnaissance West Pilbara

Granitoid intrusions into the Mallina Basin are reported to have geochemical signatures that indicate a juvenile mantle component in combination with crustal contamination (Smithies, pers comm 2000). This could indicate that a subduction event took place prior to extraction of the granitoids from their source region. Mafic and intermediate intrusions in the Mallina Basin have been sampled for a geochemical study. The aim is to characterize the condition of the mantle beneath the Mallina Basin.

The other objective of the geochemical study is a chemical characterization of the mafic rocks in the West Pilbara. Analysis of selected gabbroic and basaltic samples is currently in progress. If the results are promising a Sm-Nd isotopic study will be carried out. This technique is especially useful in terrane characterization: it allows distinguishment between juvenile and recycled components and the identification of periods of new crust formation.

Financiëel overzicht

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Bijdrage Universiteit Utrecht aan promotie veldwerk Hfl 6000
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