Radiation Measurements 50 (2013) 187–191

Contents lists available at SciVerse ScienceDirect

Radiation Measurements

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

Apatite fission-track data from upper Cretaceous formations in the Yuan'an Graben (China): Constraints on the timing of synsedimentary fault activity

Lei Peng [a,b], Chuanbo Shen [a,*], Zhao Yang [c], Xiang Ge [b]

[a] Key Laboratory of Tectonics and Petroleum Resources, Faculty of Earth Resources, China University of Geosciences, Ministry of Education, Wuhan 430074, China
[b] Faculty of Earth Resources, China University of Geosciences, Wuhan 430074, China
[c] Department of Geology, Northwest University, Xi'an 710069, China

HIGHLIGHTS

► Apatite fission-track dating is used to constraint on the timing of fault activity.
► The onset time of extension in Jianghan Basin is ca. 117 Ma.
► Combination of AFT and ESR to determine a Graben evolution.

ARTICLE INFO

Article history:
Received 3 December 2011
Received in revised form
5 February 2012
Accepted 29 June 2012

Keywords:
Fission-track
Synsedimentary fault
Fault activity
Cretaceous
Jianghan Basin

ABSTRACT

Apatite fission-track signatures of upper Cretaceous Formations in the Yuan'an Graben are made to constraint on the timing of the Yuan'an and Tongchenghe synsedimentary fault activity. The apatite fission-track ages range from 102.0 ± 14.6 to 84.1 ± 3.7 Ma with $P(\chi^2)$ >0.05; the mean confined track lengths of 14.18 ± 0.09 and 14.16 ± 0.08 μm with mean D_{par} values of 2.25 ± 0.02 and 2.26 ± 0.03 μm, respectively. These data are interpreted as dating their source-area exhumation, recording the exhumation and cooling of the footwall during major normal faulting. The results indicate that the timing of the Yuan'an and Tongchenghe synsedimentary fault activity occurred at 117–82 Ma and the intensive movement at 100–82 Ma; the onset time of extension in Jianghan Basin is ca. 117 Ma, which is related to the lithospheric extension associated with the subduction of the Pacific Plate beneath the Asian Plate.

1. Introduction

Determining the absolute timing of fault activities remains challenges and also is more difficult (Siebel et al., 2010). Traditionally, stratigraphic or intrusive/extrusive geological markers have been often used as the most direct way to achieve the timing of normal faulting but lack of enough datable (Stockli, 2005). More recent studies have highlighted the potential for constraint on the timing of onset, duration, and rates of extensional faulting, block tilting and exhumation using fission-track thermochronology (Ehlers et al., 2001, 2003; Redfield et al., 2005; Stockli, 2005; Hendriks et al., 2010; Zwingmann et al., 2010). Synsedimentary fault or growth fault is a particular type of normal fault in sedimentary basin that develops and moving during ongoing sedimentation, thus the deposition and fault movement can be thought to occur at the same time. Footwall rocks move relatively upwards during major normal faulting, leading to exhumation and cooling of the footwall and contemporaneously deposition of the hangingwall, such that the timing of fault activity can be estimated from the cooling age of the footwall or the maximal depositional age of the hangingwall stratum (e.g., Ehlers and Chapman, 1999; Stockli, 2005).

In this study, three sandstones from Cretaceous sediments in the Yuan'an Graben were analyzed for apatite fission-track (AFT) dating that gives the cooling age of the source-area. Integrating the electron spin resonance (ESR) dating for quartz minerals of fault rock within fault zone and previous published AFT data provides direct constraints on the absolute timing of the Yuan'an and Tongchenghe synsedimentary fault activities and the relationship between the exhumation of the footwall and contemporaneously deposition of the Yuan'an Graben by normal faulting.

2. Geological setting

The Yuan'an Graben is located at the Jianghan Basin, central China, bounded by NWW-trending Yuan'an and Tongchenghe

* Corresponding author. Tel.: +86 27 87481219; fax: +86 27 67883051.
E-mail addresses: cugshen@yahoo.com.cn, cugshen@yahoo.cn (C. Shen).

1350-4487/$ – see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.radmeas.2012.06.022

synsedimentary fault (Fig. 1a). The Jianghan Basin, covering nearly 28,000 km^2, is a large Cretaceous–Tertiary rift petroliferous basin outlined by NNE-trending normal faults (Dai et al., 2000). It is surrounded by the Qinling–Dabie orogen (NE), the Jiangnan orogen (S), and the Huangling dome (NW) (Fig. 1a insert). The basin fill is regionally similar, comprising relatively coarse-grained alluvial fan and/or deltaic deposits that grade up-section into lacustrine mudstones (Dai et al., 2000; Shen et al., 2012a). The Cretaceous sediments comprise, from base (Lower Cretaceous) to top (Upper Cretaceous), the Shimen (K_1s), the Wulong (K_1w), the Luojingtang (K_2l), the Honghuatao (K_2h) and the Paomagang (K_2p) Formations (Fig. 1b). The K_1s varies from 12 to 185 m in thicknesses and is composed of gray, yellow and red conglomerates with interbedded siltstones. The K_1w is 714–1696 m thick and consists mainly of gray–yellow and gray–red siltstones and medium-grained sandstones with interbedded sandy conglomerate and conglomerate in the lower unit. The K_2l with 270–812 m thick consists of red–white massive conglomerate with thin-bedded sandstone and siltstone. The K_2h is 269–1420 m thick and underlies the K_2p (263–805 m thick), both of which are composed of massive red fine-grained sandstone, siltstone and mudstone (Fig. 1b). The Luojingtang, the Honghuatao and the Paomagang Formations constitute sediments of The Yuan'an Graben (Fig. 1a).

3. Samples and methodology

Samples 10YA1 (111°38.7640′E, 30°53.4749′N, 152.6 m), 10YA2 (111°37.4908′E, 30°57.4206′N, 148.9 m) and 10YA3 (E111°37.3266′, 31°04.0417′N, 124.4 m) were collected from K_2h, K_2l and K_2p respectively (Fig. 1b). The main lithology of the samples for AFT dating is the sandstone. Rock samples were crushed in a steel jaw crusher. A shaking bed and heavy liquid techniques were used to concentrate heavy minerals. Apatite grains were separated from other heavy minerals by hand picking under a binocular microscope. AFT analysis was performed at Bergakademie Freiberg following the methods detailed in Enkelmann et al. (2006). The apatite mounts were etched in 4.0 M HNO_3 for 15 s at 25 °C and the muscovite external detectors in 40% HF for 30 min at room temperature. IRMM 540R standard uranium glasses were embedded together with the age standards ($\zeta_{IRMM} = 278.4 \pm 5.1$ a.cm^2). Separate mounts (samples 10YA2 and 10YA3) for track-length measurements were irradiated with heavy

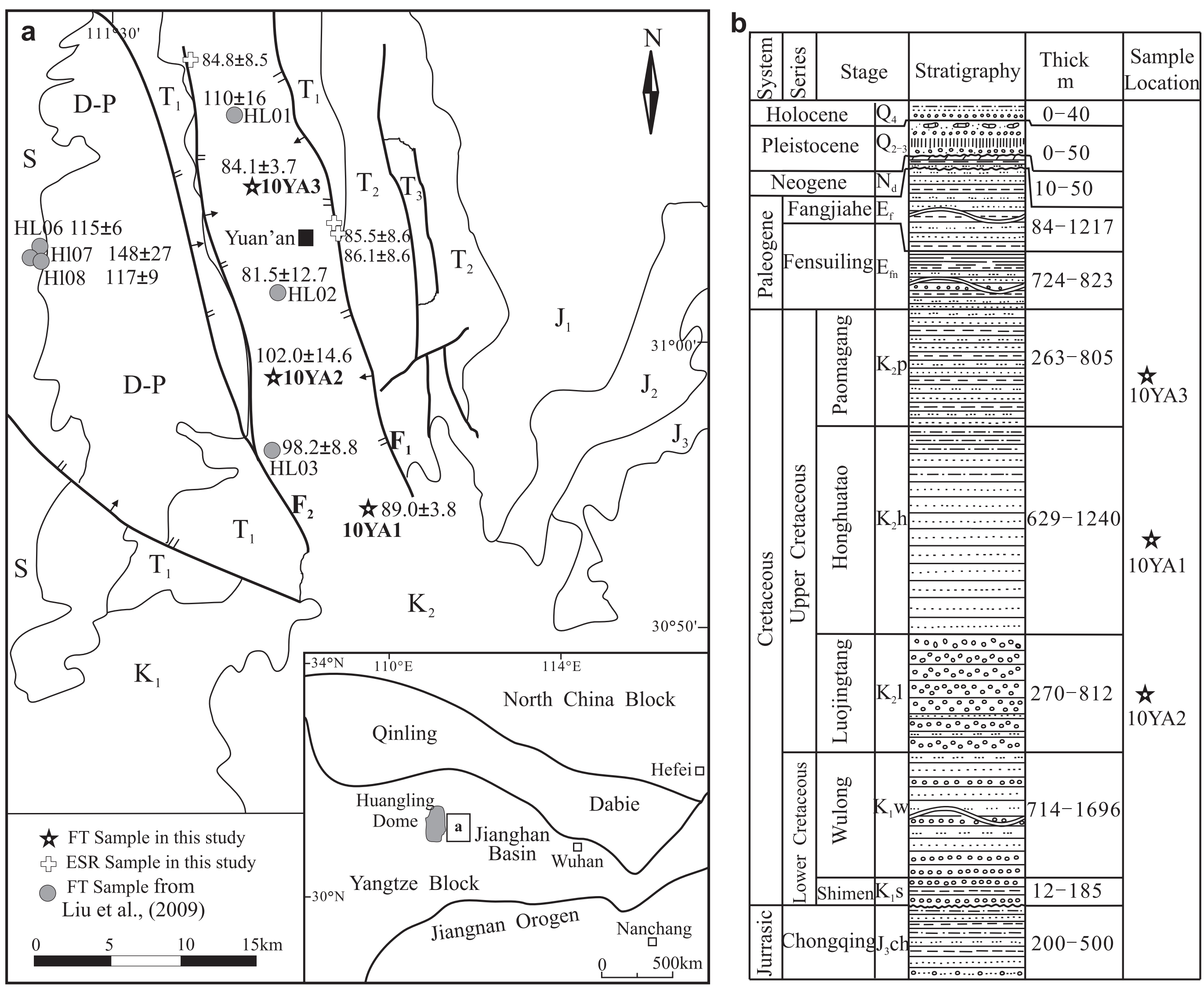

Fig. 1. a, Simplified geological map for the Yuan'an Graben in the Jianghan Basin and sample locations, modified from Liu et al. (2009). b, Stratigraphy of Cretaceous sequence of the Jianghan Basin with showing sample sites. F_1, Yuan'an fault; F_2, Tongchenghe fault.