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Early Cretaceous provenance change in the southern Hailar Basin, northeastern China and its implication for basin evolution

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ABSTRACT

Gamma-ray (GR) logging and detrital zircon geochronology provide new constraints on changing provenance in the southern Hailar Basin of northeastern China. The basement of this region is characterized by low GR values of 70–90 API. This is overlain by a rift-fill sequence, the GR values of which exhibit a broad range in its lower part (70–160 API), but a more restricted range (80–110 API) in its upper part. Post-rift sediments dominate the basin fill, and are characterized by higher GR values of 120–160 API. Detrital zircon samples from the lower rift sequence and post-rift sediments share similar age distributions, with a single dominant age population of 150–110 Ma. Samples from the upper rift sequence exhibit a bimodal age distribution with peaks at 180–150 Ma and 360–300 Ma. The synchronous changes in zircon age populations and GR values in the strata suggest changing sedimentary source characteristics, thus revealing a rapid shift from active rifting to post-rift thermal sagging of the Hailar Basin in the Early Cretaceous. The basal rift-fill deposits are interpreted to have been mainly derived from erosion of local highs internal to the basin itself, although acidic air-fall ash from the extensive late Mesozoic volcanism in the Great Xing'an Range probably also contributed. Post-rift sediments are dominated by materials shed from the Great Xing'an Range magmatic belt.

1. Introduction

Widespread extension occurred across northeast China and adjacent areas during the late Mesozoic, with the period characterized by broad rifting (Zhang, 1997; Graham et al., 2001; Ren et al., 2002; Meng, 2003), extensive magmatism (Fan et al., 2003; Wu et al., 2005; Wang et al., 2006; Zhang et al., 2008a, b, c, 2010, 2011) and exhumation of metamorphic core complexes (Shao et al., 2001; Davis et al., 2002; Daoudene et al., 2009) throughout northeast Asia (Fig. 1A). Understanding of basin structure and fill in this region has advanced rapidly over the past two decades, driven in particular by petroleum exploration (notably in the productive Songliao, Erlian, Hailar and East Gobi basins) (e.g., Yang et al., 1985; Watson et al., 1987; Zhai, 1993; Hu et al., 1998; Graham et al., 2001; Lin et al., 2001; Ren et al., 2002; Meng, 2003; Meng et al., 2003; Chen et al., 2007; Cao et al., 2009; Jiang et al., 2009).

The Hailar Basin encompasses an area of ca. 40,550 km^2 on the western flank of Great Xing'an Range magmatic belt (Fig. 1A and C). This basin has a dominant northeast-trending architecture, and contains up to 4–5 km of late Mesozoic–Cenozoic non-marine sediments, with a similar overall stratigraphy to that of the adjacent Tamstag Basin in Mongolia to the south (Zhang and Long, 1995). The stratigraphic, sedimentary and structural evolution of the Hailar Basin has been studied intensively in recent years through combined seismic and drilling investigation (Huang et al., 2005, 2006; Wu et al., 2006; Wan, 2006; Chen et al., 2007; Hou et al., 2008; Cao et al., 2009). It is widely accepted that the basin underwent rifting in the Early Cretaceous, but the dynamic attributes of the subsequent post-rift phase remain controversial, with arguments for dominance of both compression (Liu et al., 2006, 2009), strike-slip (Hou et al., 2008) and thermally subsiding sag (Cao et al., 2009; Zhang, 2009). Basin dynamics and the relationship between the Hailar Basin and the flanking Great Xing'an Range remains poorly understood. This investigation comprises a new

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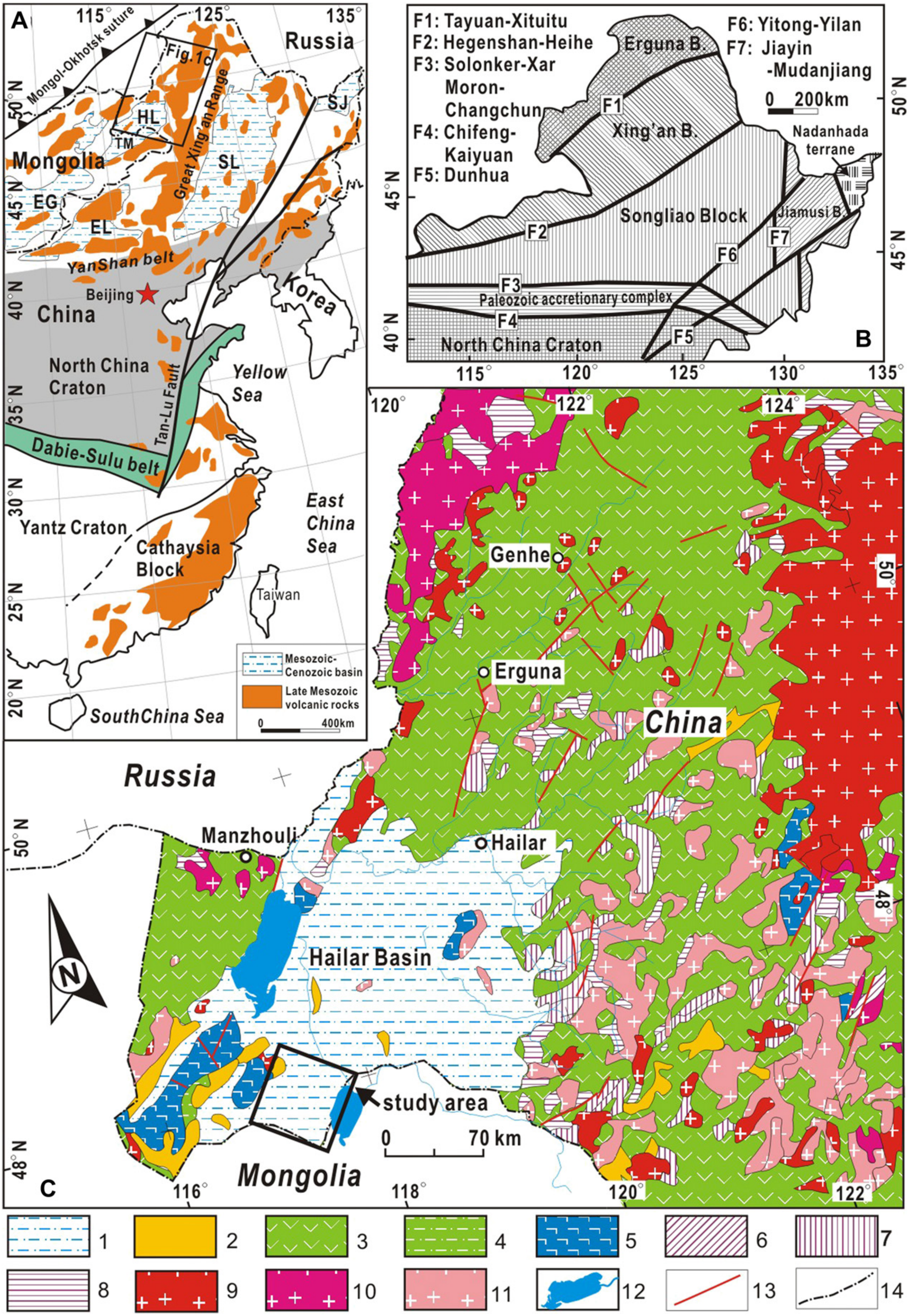
A
115°
125°
135°
Mongol-Okhotsk suture
Fig.1c
Russia
50° N
HL
TM
SJ
Mongolia
Great Xing'an Range
SL
45° N
EG
EL
YanShan belt
Beijing
40° N
China
Korea
North China Craton
Tan-Lu Fault
Yellow Sea
35° N
Dabie-Sulu belt
30° N
East China Sea
Yantz Craton
Cathaysia Block
25° N
Taiwan
20° N
SouthChina Sea
Mesozoic-Cenozoic basin
Late Mesozoic volcanic rocks
0 400km
F1: Tayuan-Xituitu
F2: Hegenshan-Heihe
F3: Solonker-Xar Moron-Changchun
F4: Chifeng-Kaiyuan
F5: Dunhua
F6: Yitong-Yilan
F7: Jiayin -Mudanjiang
Erguna B.
F1
Xing'an B.
0 200km
50° N
Nadanhada terrane
45° N
Songliao Block
Jiamusi B.
F2
F7
F6
F3
Paleozoic accretionary complex
F4
F5
40° N
North China Craton
B
115° 120° 125° 130° 135°
120°
122°
124°
Genhe
50°
Erguna
China
Russia
Manzhouli
Hailar
50° N
48°
Hailar Basin
study area
0 70 km
48° N
Mongolia
C
116°
118°
120°
122°
1 2 3 4 5 6 7
8 9 10 11 12 13 14