Physics of the Earth and Planetary Interiors 224 (2013) 104–123

Contents lists available at ScienceDirect

Physics of the Earth and Planetary Interiors

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

Review

Seismic imaging of the deep structure under the Chinese volcanoes: An overview ☆

Jianshe Lei [a,*], Furen Xie [a], Qicheng Fan [b], M. Santosh [c]

[a] Key Laboratory of Crustal Dynamics, Institute of Crustal Dynamics, China Earthquake Administration, Beijing 100085, China
[b] Institute of Geology, China Earthquake Administration, Beijing 100029, China
[c] School of Earth Sciences and Resources, China University of Geosciences, Beijing 100083, China

ARTICLE INFO

Article history:
Received 1 March 2013
Received in revised form 6 August 2013
Accepted 21 August 2013
Available online 30 August 2013
Edited by G. Helffrich

Keywords:
Seismic tomography
Seismic structure
Upper mantle
Volcano
Chinese continent

ABSTRACT

The rapid development of provincial seismic networks and portable seismic arrays has provided a good opportunity to image the detailed 3-D seismic structure of the upper mantle under the active volcanoes in the Chinese continent. Under the Changbaishan (Tianchi) volcano prominent low-velocity (low-V) anomalies are imaged above 400 km depth, and high-velocity (high-V) anomalies are detected within the mantle transition zone, suggesting that the Changbaishan volcano is a back-arc volcano related to the dehydration of the subducted Pacific slab that is stagnant in the mantle transition zone. Seismic structures under the Tengchong volcano are similar to those under the Changbaishan volcano, whereas the subducted slab under the Tengchong volcano is the continental Indian slab. Regional and global tomographic models illustrate that obvious low-V anomalies are visible under the Hainan volcano from the crust down to the lower mantle, suggesting that the Hainan volcano is a hotspot. A recent local tomographic model shows that the Hainan plume is imaged as a southeast tilted low-V anomaly with depth in the upper mantle. A high-resolution upper-mantle tomographic model under the North China Craton shows a significantly Y-shaped low-V anomaly under the Datong volcano and Bohai Sea extending down to the lower mantle, which, for the first time, is inferred using precise teleseismic arrival times hand-picked from high-quality seismograms recorded at densely spaced stations from the Chinese provincial networks. The results indicate the possibility of a mantle plume beneath the region. These models suggest that the Changbaishan and Tengchong volcanoes share the history of deep mantle origin, whereas the Datong and Hainan volcanoes are comparable. All these results provide a better understanding of the dynamics of East Asia, and also call for future volcanic hazard mitigation.

Contents

* Corresponding author. Tel./fax: +86 10 62846760.
E-mail addresses: leijs@eq-icd.cn, jshlei_cj@hotmail.com (J. Lei).

0031-9201/$ - see front matter © 2013 The Authors. Published by Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.pepi.2013.08.008

1. Introduction

The complex tectonic architecture of East Asia includes the growing Tibetan plateau and Tianshan mountains, the stable Sichuan and Tarim basins, and the lithospheric erosion beneath the North China Craton (Fig. 1). These features have been correlated to the collision of the Indian and Eurasian plates to the southwest (e.g., Molnar and Tapponnier, 1975; England and Houseman, 1986; Tapponnier et al., 1986; Yin and Harrison, 2000; Liu et al., 2004; Guo and Wilson, 2012) and the subduction of the Philippine Sea and Pacific plates to the east (e.g., Fukao et al., 1992; Bijwaard et al., 1998; Zhao, 2004; Abdelwahed and Zhao, 2007; Lei and Zhao, 2005, 2006a; Li and van der Hilst, 2010; Zhao et al., 2012a). Along these tectonic boundaries are distributed many large and active faults and rifts, such as the Tanlu fault and Shanxi rift in eastern China, and the Kunlunshan fault, Xianshui River fault, the Longmenshan fault zones, and the Red-River fault in western China (Fig. 1) (Deng et al., 2002). In addition, around these fault zones some large earthquakes occurred historically and recently. Some well-known examples are the 25 September 1303 Hongtong, Shanxi, earthquake (M 8.0), the 2 February 1556 Huaxian, Shaanxi earthquake (M 8.25), the 14 November 2001 Kunlun earthquake (M 8.1), the 12 May 2008 Wenchuan earthquake (M 8.0), and the 14 April 2010 Yushu earthquake (M 7.1) (Song et al., 2011). These destructive earthquakes caused immense damage to life and property.

Active volcanoes pose another form of serious natural disasters in the Chinese continent (Fig. 1). Volcanoes act as the vents for extremely high-temperature magma ascending upward from the mantle through the crust to the surface. Volcanoes are defined as active if they were recorded at least one eruption in the Holocene. Accord-

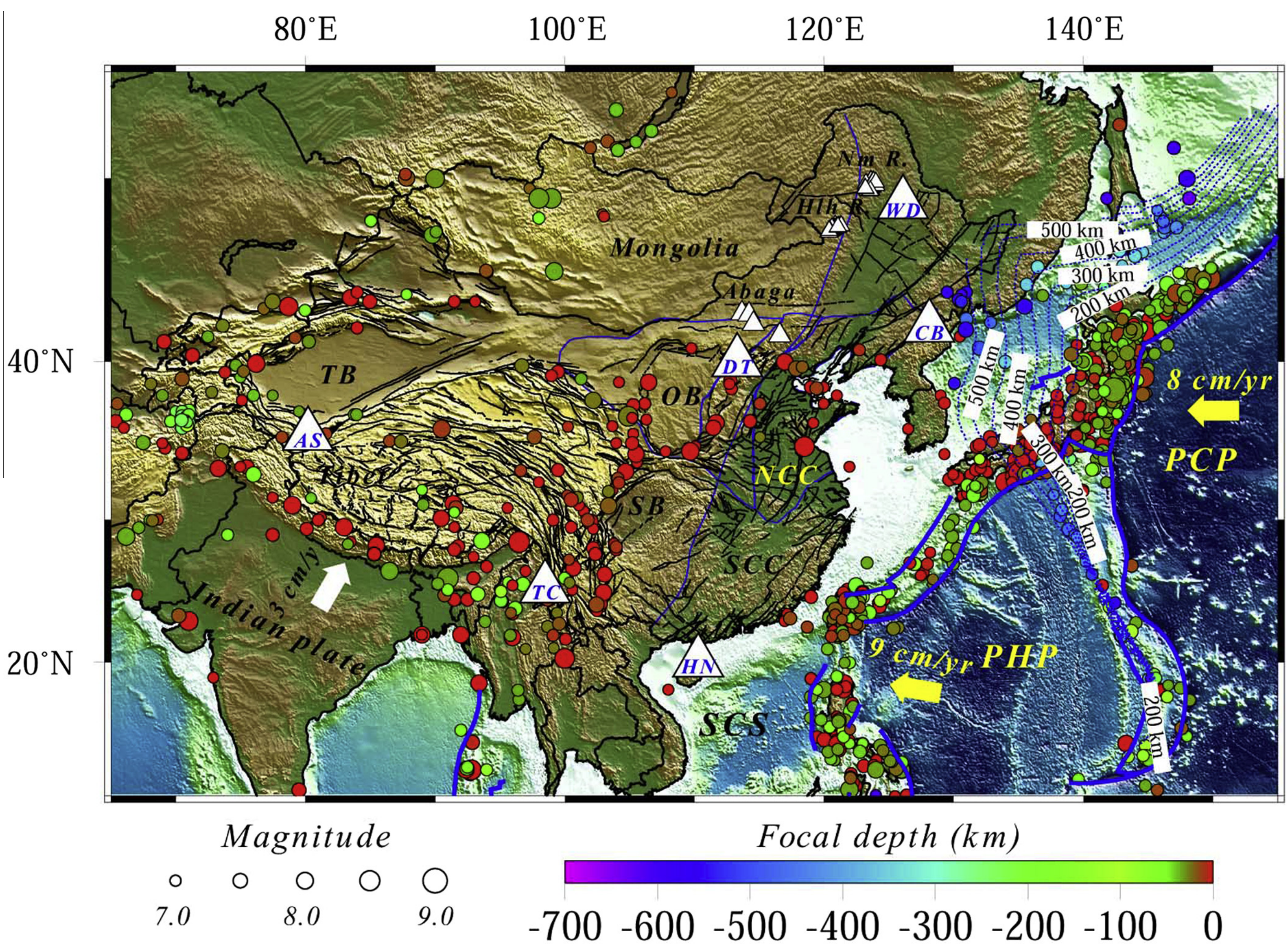

Fig. 1. Distribution of volcanoes (large triangles with letters) in China underlain by topography. WD, the Wudalianchi volcano; CB, the Changbaishan volcano; DT, the Datong volcano; TC, the Tengchong volcano; HN, the Hainan volcano; AS, the Ashikule (Kunlun) volcano. Small triangles denote the volcanoes along the Xing'an-Mongolia orogenic belt. Abaga, the Abaga volcanic group; Hlh R., the Halaha River volcanic group; Nm R., the Nuomin River volcanic group. The NS oriented blue line denotes the North–South Gravity Lineament. Color circles denotes the earthquakes with magnitude larger than 7.0 since BC 780 (Song et al., 2011). The scales for earthquake magnitude and focal depth are shown at the bottom. NCC, the North China Craton; SCC, the South China Craton; SB, the Sichuan basin; OB, the Ordos block; TB, the Tarim basin; PCP, the Pacific plate; PHP, the Philippine Sea plate; SCS, the South China Sea; Thick arrows denote the directions of absolute plate motion, and their velocities are shown on the side of the arrows. Dashed lines denote depth contours of the upper boundary of the subducted Pacific slab (Gudmundsson and Sambridge, 1998). Thick blue lines denote major plate boundaries. Thin black lines denote the major active faults (Deng et al., 2002).