THREE-DIMENSIONAL MODELING OF THE DRIVING MECHANISM OF THE 1976 TANGSHAN EARTHQUAKE IN CHINA

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ABSTRACT

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A three-dimensional creep model of the driving mechanisms of the 1976 Tangshan earthquake is presented, with consideration of both the body force and the regional tectonic force. The upper crust is assumed to be a visco-elastic body, the strain rate for the viscous component is assumed to be linearly proportional to the deviatoric stress, but the lower crust and the upper mantle respond to the stress as a non-linear Newtonian fluid obeying the power law of creep. This model is solved numerically using the principle of additively of elastic, plastic and viscous strains, as well as the initial strain method with a tangential modulus for the upper crust and with a secant modulus for both the lower crust and the upper mantle to represent the energy dissipation of creep flow.

Computed results show that: 1) to match roughly the pre-seismic ground surface leveling and the co-seismic dip- and strike-slip, uplifting beneath the doming zone of the crust-mantle boundary plays a more important role than a horizontal driving mechanism; 2) the lower-crust fault first relaxes the strain induced by the uplift, resulting in stress accumulation in the upper crust, expecially at the front of the tip of the Tangshan fault lying above the crustal low-velocity zone; 3) significant co-seismic and post-seismic ground-surface displacements along the newly faulted belt in Tangshan result from a combination of elastic strain rebound and change in gravitational potential.

INTRODUCTION

According to Huang (1980), stratigraphic, structural and seismic evidence indicates that cataclastic flow has been dominant in China since the late Paleozoic, and the present-day mechanical fabric of China was formed as a result of the Permo-Triassic and Cenozoic plate-tectonic collapse; there are six stable and rigid basement elements in China; and sediment patterns over the rigid basement blocks are uniform and lack sediment structures with steeply dipping faults at shallow depth; deformed ductile zones are made of

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up fragments; the regions between the rigid blocks and ductile zones are mechanically similar to the ductile zones.

Cenozoic plate motions caused continental collision in south-western China; however, only grabens formed in eastern China where island arcs moved away from the mainland. The driving mechanism for this graben formation is still uncertain. Both brittle elements and ductile zones have been rifted and cut by strike-slip faults in eastern China (Ma, 1984).

Basement behaviour in China can be characterized as follows: 1) where earthquakes occur, the behaviour is brittle; 2) where earthquakes do not occur, and there is evidence of strong deformation, the behaviour is purely

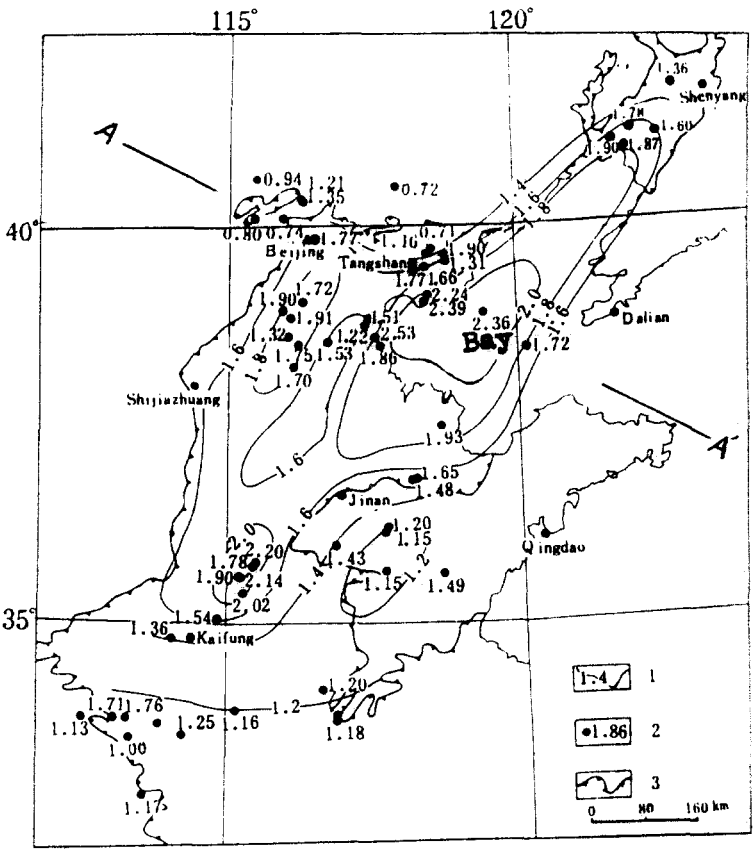

Fig. 1. Heat flow (HFU) distribution of the North-China plain (Mei, 1982).