U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

OPEN-FILE REPORT 2007-1103
This report is USGS Afghanistan Project Product No. 150
Pamphlet accompanies map

Probable and Possible Quaternary Faults of Afghanistan

By
Chester A. Ruleman, Anthony J. Crone, Michael N. Machette,
Kathleen M. Haller, and Kenneth S. Rukstales

2007

ABSTRACT

The U.S. Geological Survey (USGS), with support from the U.S. Agency for International Development (USAID) mission in Afghanistan, has prepared a digital map showing the distribution of probable and suspected Quaternary faults in Afghanistan. This map is a key component of a broader effort to assess and map the country's seismic hazards. Our analyses of remote-sensing imagery reveal a complex array of tectonic features that we interpret to be probable and possible active faults within the country and in the surrounding border region. In our compilation, we have mapped previously recognized active faults in greater detail, and have categorized individual features based on their geomorphic expression. We assigned mapped features to eight newly defined domains, each of which contains features that appear to have similar styles of deformation. The styles of deformation associated with each domain provide insight into the kinematics of the modern tectonism, and define a tectonic framework that helps constrain deformational models of the Alpine-Himalayan orogenic belt.

The modern fault movements, deformation, and earthquakes in Afghanistan are driven by the collision between the northward-moving Indian subcontinent and Eurasia. The patterns of probable and possible Quaternary faults generally show that much of the modern tectonic activity is related to transfer of plate-boundary deformation across the country. The left-lateral, strike-slip Chaman fault in southeastern Afghanistan probably has the highest slip rate of any fault in the country; to the north, this slip is distributed onto several fault systems. At the southern margin of the Kabul block, the style of faulting changes from mainly strike-slip motion associated with the boundary between the Indian and Eurasian plates, to transpressional and transtensional faulting. North and northeast of the Kabul block, we recognized a complex pattern of potentially active

strike-slip, thrust, and normal faults that form a conjugate shear system in a transpressional region of the Trans-Himalayan orogenic belt.

The general patterns and orientations of faults and the styles of deformation that we interpret from the imagery are consistent with the styles of faulting determined from focal mechanisms of historical earthquakes. Northwest-trending strike-slip fault zones are cut and displaced by younger, southeast-verging thrust faults; these relations define the interaction between northwest-southeast-oriented contraction and northwest-directed extrusion in the western Himalaya, Pamirs, and Hindu Kush regions. Transpression extends into north-central Afghanistan where north-verging contraction along the east-west-trending Alburz-Marmul fault system interacts with northwest-trending strike-slip faults. Pressure ridges related to thrust faulting and extensional basins bounded by normal faults are located at major stepovers in these northwest-trending strike-slip systems. In contrast, young faulting in central and western Afghanistan indicates that the deformation is dominated by extension where strike-slip fault zones transition into regions of normal faults. In addition to these initial observations, our digital map and database provide a foundation that can be expanded, complemented, and modified as future investigations provide more detailed information about the location, characteristics, and history of movement on Quaternary faults in Afghanistan.

REFERENCES

Chirico, P.G., and Barrios, Boris, 2005, Void filled SRTM digital elevation model of Afghanistan: U.S. Geological Survey Data Series 130, 1 disc (available at: http://pubs.er.usgs.gov/usgspubs/ds/ds130).

Ruleman, C.A., Crone, A.J., Machette, M.N., Haller, K.M., and Rukstales, K.S., 2007, Map and database of probable and possible Quaternary faults in Afghanistan: U.S. Geological Survey Open-File Report 2007-1103, 39 p., 1pl.

Figure 1. Kinematic model for probable and possible Quaternary faults in Afghanistan. Based on our remote-sensing analyses, we have identified kinematic indicators for fault displacement (for example, shutter ridges and displaced geologic units and landforms) in order to construct a preliminary model for the kinematic mechanics of crustal deformation in Afghanistan. Field-based studies have not been performed to confirm our observations. However, initial interpretations provide a basic model to enhance as more investigations occur.

Figure 2. Based on characteristics of the surficial expression of faulting, we have subdivided mapped probable and possible Quaternary faults into three categories: A, B, and C. Category A faults are considered to be major structures with a prominent expression in the landscape and are likely to play an important role in seismic hazards. Based on the similarity in surficial expression to other faults of known slip rate within the region, we assign a slip rate of >10 mm/yr to these faults. Category B faults are minor structures that have a distinct expression in the landscape and could be significant contributors to Afghanistan's seismic hazard. The surficial expression of faulting is easily traceable, but more discontinuous than category A faults, indicating possible

longer recurrence times and slower slip rates. We assign category B faults a slip rate of 1–10 mm/yr. Category C faults are structures that have a subtle expression in the landscape or that have limited or poor expression in Quaternary deposits, but could possibly contribute to the seismic hazard. Category C faults have an indeterminate slip rate.

Base map data from ESRI ArcWorld 1:3M and ESRI Data and MapsShaded-relief digital topography for Afghanistan is from Chirico and Barrios (2005)

Projection: Transverse Mercator
Central Meridian 66°
WGS (World Geodetic System) 1984 datum

For product and ordering information:
World Wide Web: http://www.usgs.gov/pubprod
Telephone: 1-888-ASK-USGS

GIS and PDF files are available at http://pubs.usgs.gov/of/2007/1103