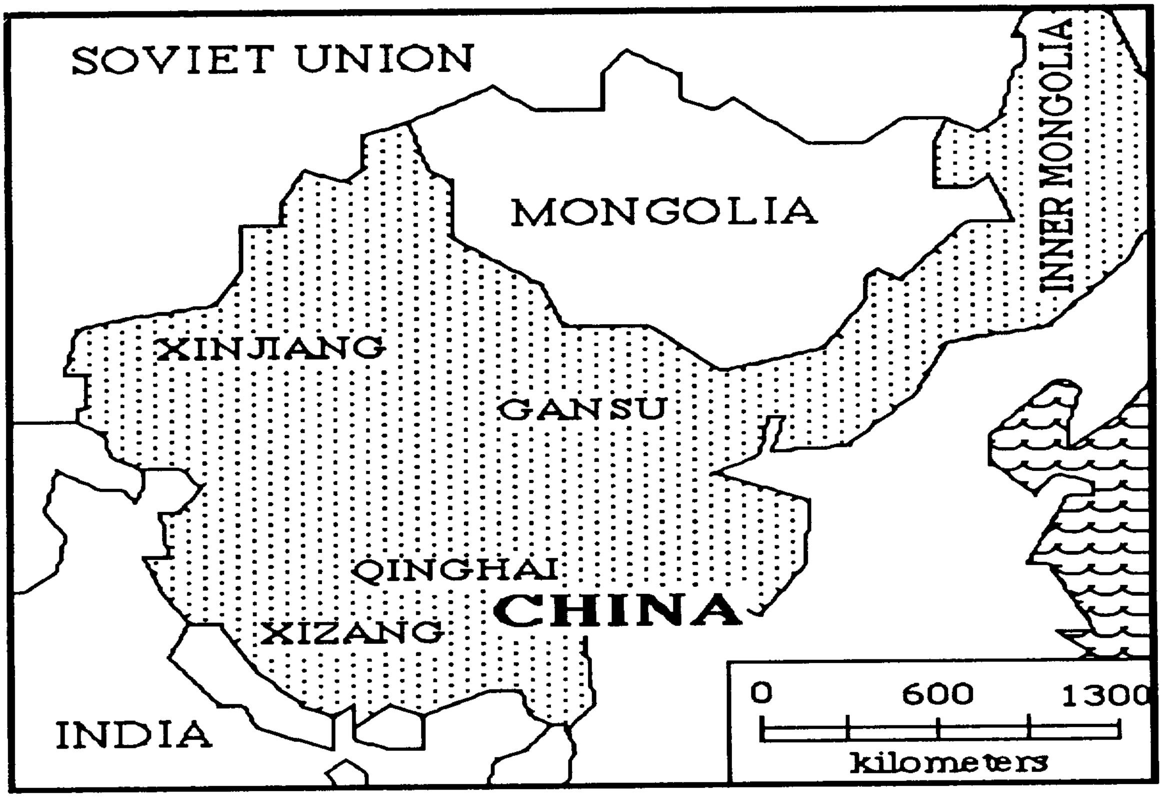
NASA-CR-193405



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Project Title: "Analysis of Gravity, Magnetic, and Seismic Reflection Data from Tibet and Neighboring Regions of China"

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(NASA-CR-193405) ANALYSIS OF GRAVITY, MAGNETIC, AND SEISMIC REFLECTION DATA FROM TIBET AND NEIGHBORING REGIONS OF CHINA Semiannual Report, Mar. - Aug. 1993 (MIT) 8 p

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Overview of Research Accomplished

Our principal effort has been devoted to completing the analysis of the new gravity data over the Tibet plateau and its margins. A paper has been completed discussing the statistical relationship between gravity and topography over the plateau, and it will be submitted for his General Examination by MIT graduate student Yu Jin. The project PI, Marcia McNutt, and Yu Jin will work together to produce a journal article for submission to the *Journal of Geophysical Research* by the end of September. Yu Jin is also in the last stages of completing a paper on the structure of the Tarim Basin as constrained by Love wave dispersion. This project has been supervised by Prof. Tom Jordan.

This research project has also supported research on the newly-released gravity data from the former Soviet Union. The results were recently published by *Kogan and McNutt* ["Gravity Field over Northern Eurasia and Variations in the Strength of the Upper Mantle", *Science*, **259**, 473-479, 1993].

Results

Numerous researchers have speculated on the role that the Tibetan uplift plays in the collision between Asian and India. According to some models, the great elevation of Tibet is caused by the underthrusting of the India lithosphere beneath Tibet. Yet another model produces uplift by crustal shortening within the Tibetan block. A third model proposes that the collision is being at least partially accommodated by displacement of terrains towards southeast Asia. The first and third model both predict that the Tibetan lithosphere would have sufficient elastic strength to resist significant internal deformation, whereas the second model, crustal shortening, assumes that Tibet is a weaker, modeled variously as a viscous or plastic sheet. The purpose of our research was to constrain the elastic strength of the Tibetan lithosphere using new gravity data (Figure 1) provided by Chinese colleagues.

We found that conventional admittance and coherence analysis fails to provide a good estimate of the elastic strength in this region, primarily on account of the fact that the nature of the tectonic deformation and uplift has produced correlated surface and subsurface loading of the elastic lithosphere. Using the power spectrum of the Bouguer gravity to estimate the depths of various subsurface density interfaces, we produced theoretical coherence curves allowing partial correlation between surface and subsurface loads in a multi-layered lithosphere. These theoretical curves provided an excellent fit to the observed coherence data for the 3 subregions of the Tibetan plateau that we modeled (Figure 2). Based on the coherence curves, we estimate that the Qiangtang block in the north-central plateau is characterized by an elastic thickness of 80 km (Figure 3a), the Lhasa block in the southern region of the plateau has an elastic thickness of 60 km (Figure 3b), and the elastic thickness of the Bayanhar block in the eastern plateau is 70-80 km (Figure 3c).

All of these elastic-thickness values are similar to that of the underthrust Indian plate to the south. Therefore, it is difficult to attribute the broad zone of deformation throughout southern Asia to a weakness in the Asian lithosphere. Furthermore, our result does not support laboratory and computer models that produce the uplift of the plateau by sliding a rigid indentor (India) into a weak viscous sheet (Tibet). Rather, our results corroborate the independent proposal by *Kogan and McNutt* [1993], based on dynamic modeling of very long-wavelength gravity and seismic velocity anomalies over northern Eurasia, that the diffuse deformation in southern Asia is facilitated by extremely low viscosity in the underlying asthenosphere.

Figures

Figure 1. Simple Bouguer gravity anomaly over Tibet.

Figure 2. Tectonic map of the Tibetan plateau showing the 3 tectonic subregions used in the coherence analysis.

Figure 3. Observed and predicted coherence assuming partial correlation between surface and subsurface loading. (a) Qiangtang block; (b) Lhasa block; (c) Bayanhar block.

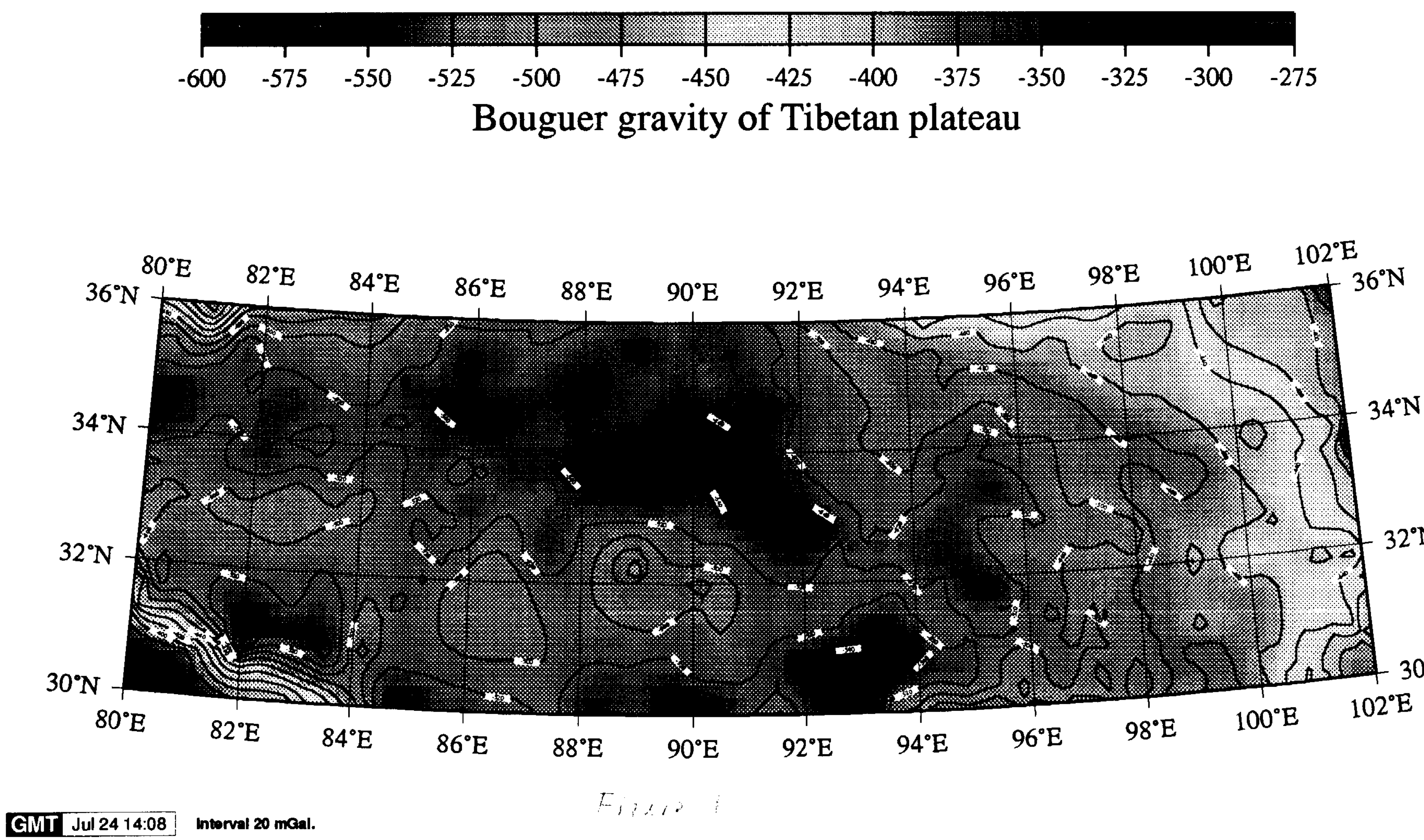
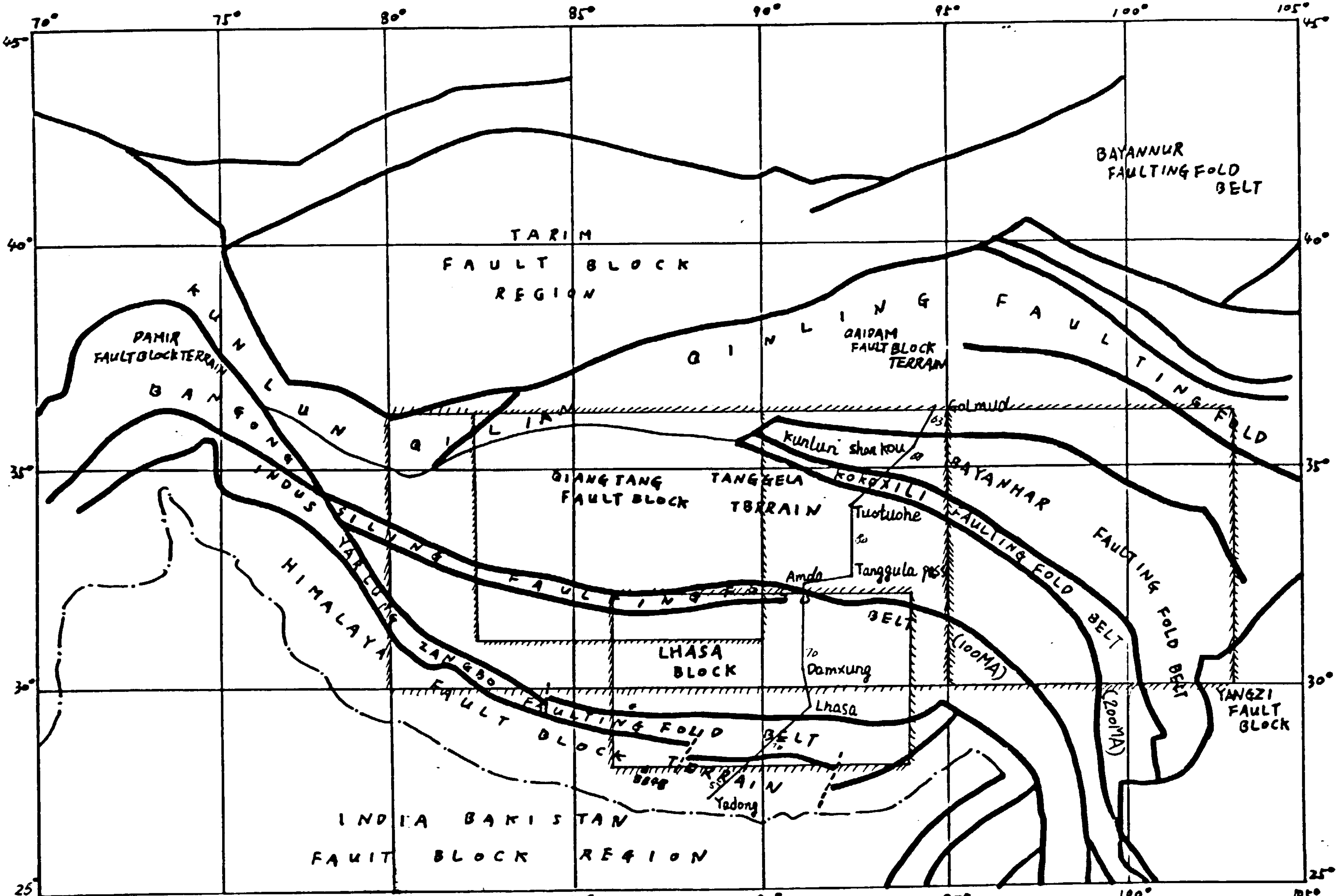

-600
-575
-550
-525
-500
-475
-450
-425
-400
-375
-350
-325
-300
-275
Bouguer gravity of Tibetan plateau
80°E
82°E
84°E
86°E
88°E
90°E
92°E
94°E
96°E
98°E
100°E
102°E
36°N
34°N
32°N
30°N
GMT Jul 24 14:08
Interval 20 mGal.

Figure 1


70°
75°
80°
85°
90°
95°
100°
105°
45°
40°
35°
30°
25°
BAYANNUR FAULTING FOLD BELT
TARIM FAULT BLOCK REGION
QINLING FAULTING FOLD
QAIDAM FAULT BLOCK TERRAIN
PAMIR FAULT BLOCK TERRAIN
KUNLUN
BANGONG
QILIAN
INDUS
Golmud
Kunlun shankou
KOKOXILI
BAYANHAR FAULTING FOLD BELT
BAYANHAR FAULTING FOLD BELT
QIANGTANG FAULT BLOCK
TANGGELA TERRAIN
Tuotuohe
Tanggula pass
Amdo
SILING FAULTING FOLD BELT
(100MA)
(200MA)
LHASA BLOCK
Damxung
Lhasa
HIMALAYA
YARLUNG ZANGBO FAULTING FOLD BELT
FAULT BLOCK TERRAIN
Yadong
YANGZI FAULT BLOCK
INDIA BAKISTAN FAULT BLOCK REGION

2

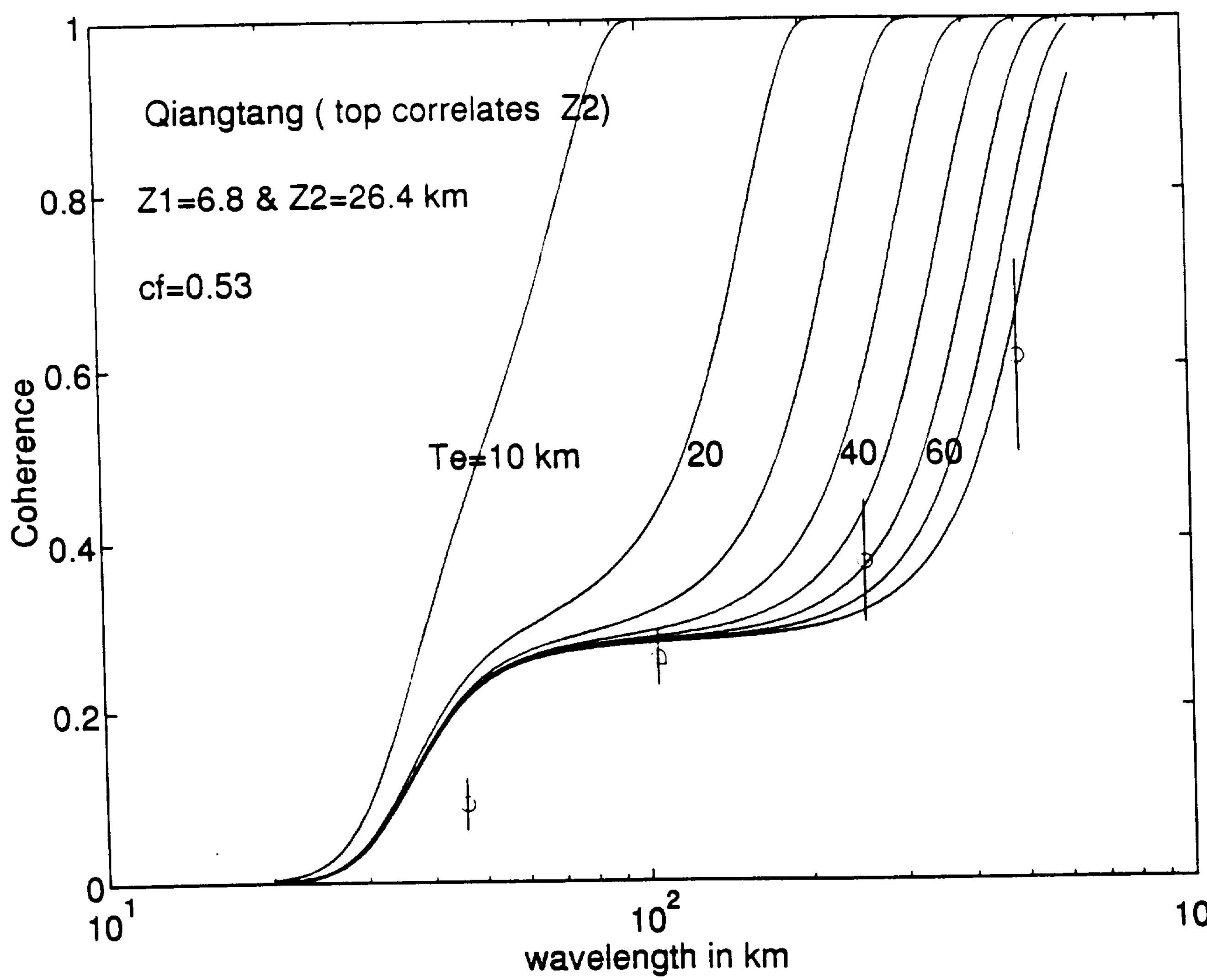

Qiangtang (top correlates Z2)
Z1=6.8 & Z2=26.4 km
cf=0.53
Te=10 km
20
40
60
Coherence
0
0.2
0.4
0.6
0.8
1
10^1
10^2
10^3
wavelength in km

Figure 3a

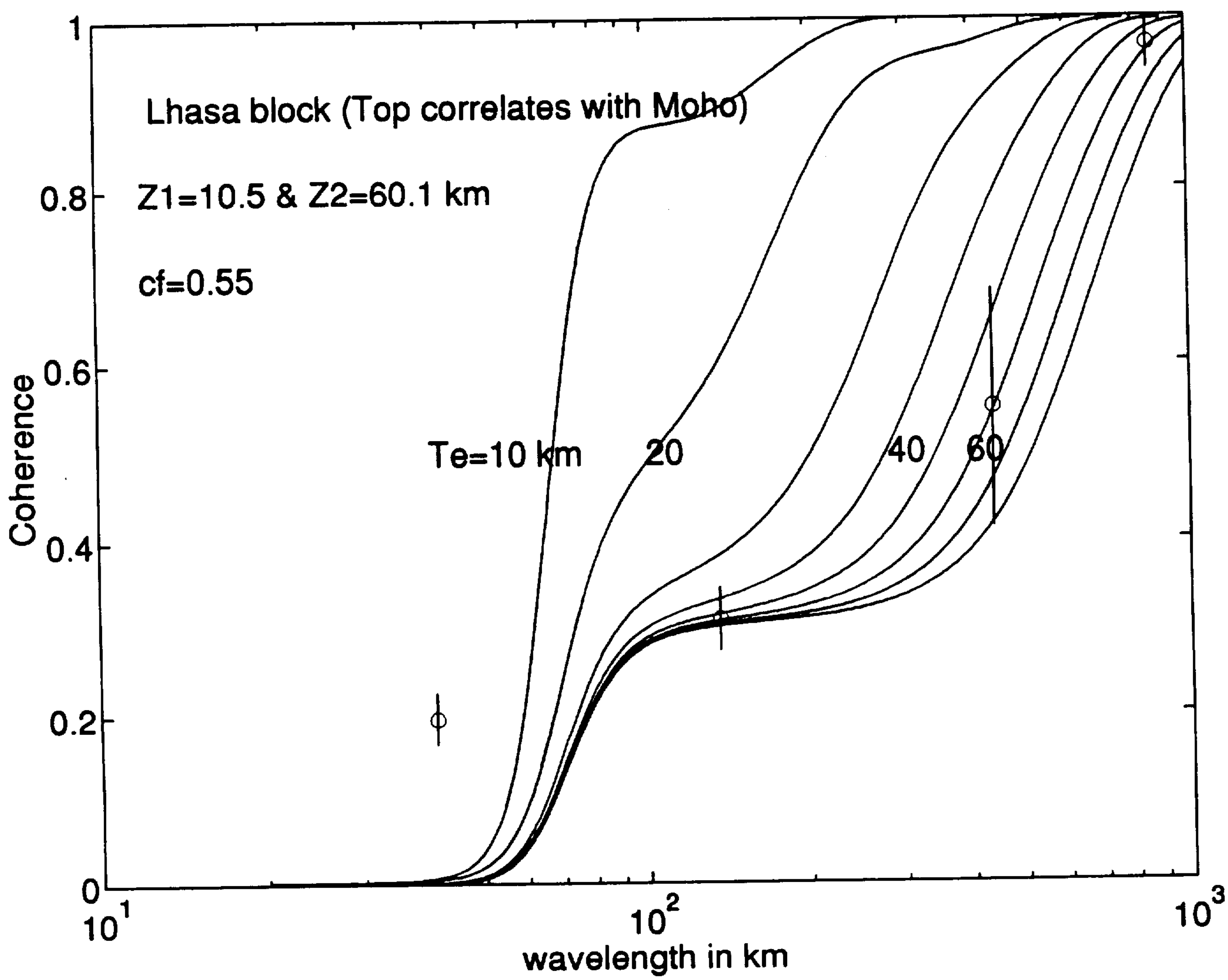

Lhasa block (Top correlates with Moho)
Z1=10.5 & Z2=60.1 km
cf=0.55
Te=10 km
20
40
60
Coherence
0
0.2
0.4
0.6
0.8
1
10^1
10^2
10^3
wavelength in km

Figure 3b

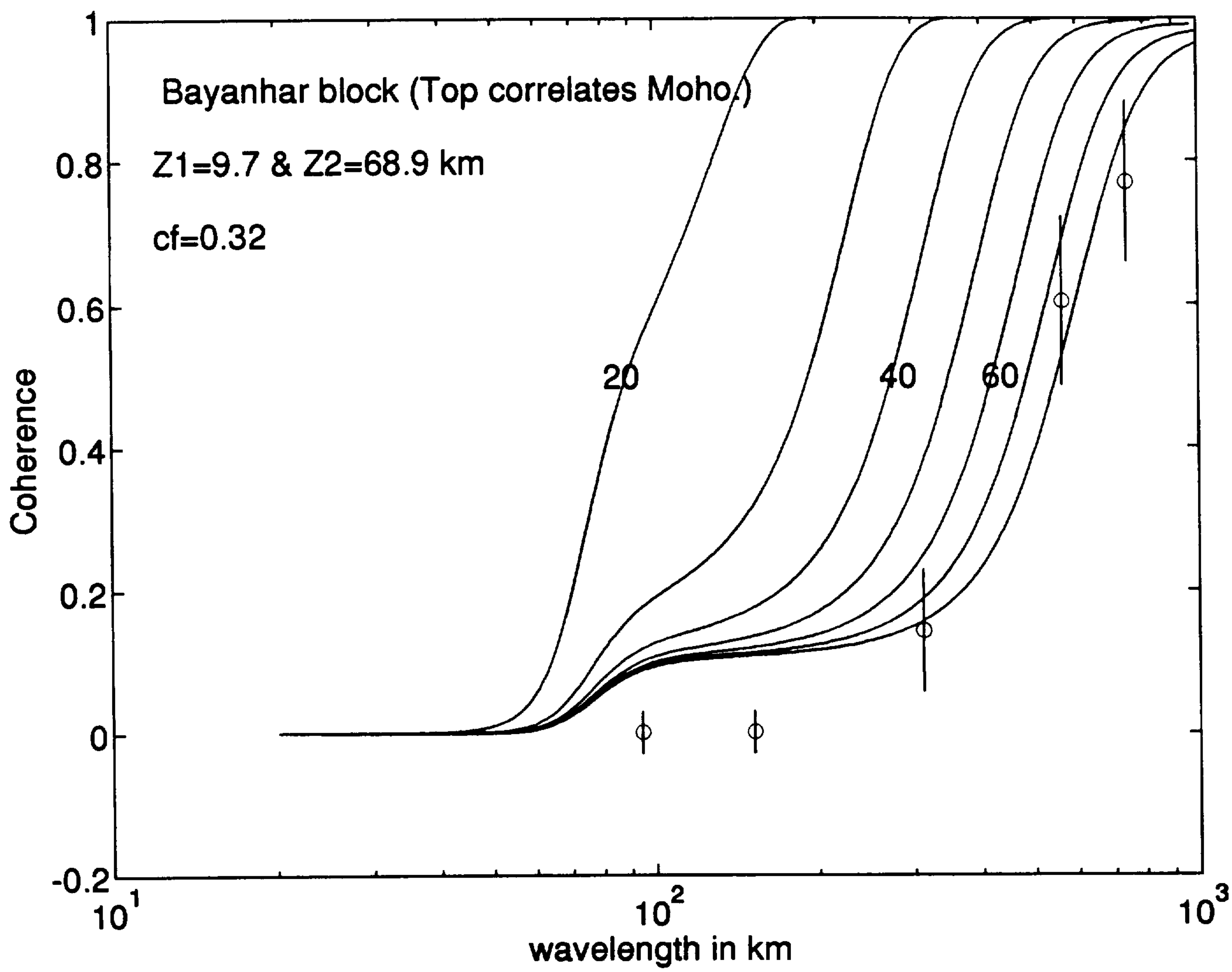

Bayanhar block (Top correlates Moho.)
Z1=9.7 & Z2=68.9 km
cf=0.32
20
40
60
Coherence
wavelength in km
1
0.8
0.6
0.4
0.2
0
-0.2
10^1
10^2
10^3

Figure 3c