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ACTIVE FAULTS OF PAKISTAN

MAP SHEETS AND INVENTORIES

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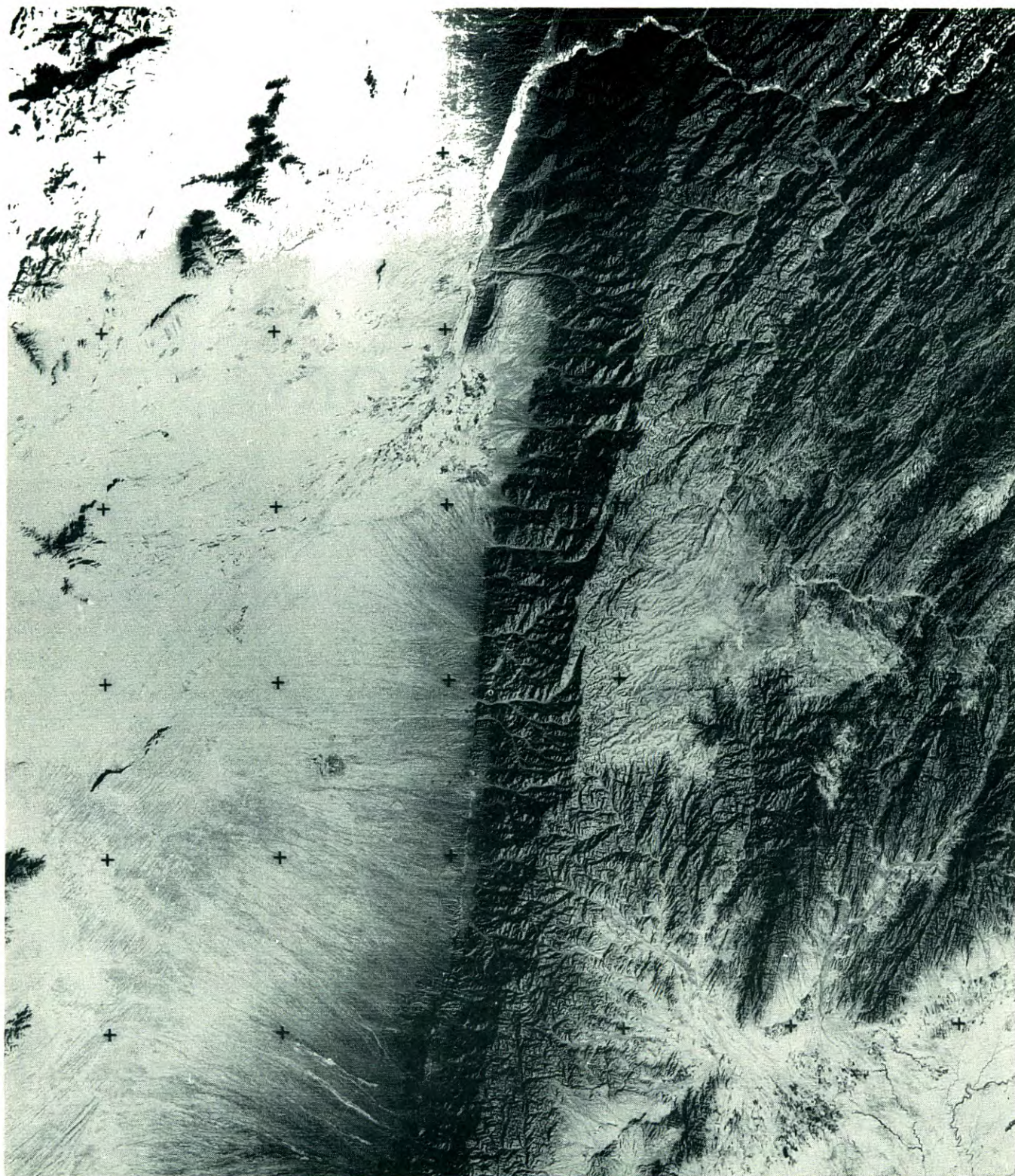
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PART I

EXPLANATORY

TEXT



Frontpiece. Landsat RBV image of the Chaman Fault in the Chaman area, Pakistan and Afghanistan (see Map sheet 34J). The active fault trends approximately north-south in the middle of the image. Numerous left-lateral offset streams are present along the fault. The area east of the fault is topographically elevated terrain underlain by Khojak Flysch. The distance between the crosses is 10 km. Landsat RBV 30285-05260-A.

1. Introduction

This volume displays the currently recognized active faults of Pakistan on 1:500,000 scale topographic maps together with tabulated inventories of fault features. Detailed material on some structures is added as space and availability allow. This is one of the first attempts to provide comprehensive information on active faults in this form for Pakistan. In this paper we define those faults that have repeatedly moved during the Late Quaternary and that may move in the future in association with destructive earthquakes as active. Some of these structures have been known for many years, but many are recognized as active for the first time in this study. The primary basis of this investigation has been the study of 1:40,000 scale aerial photographs. The newly discovered active faults have largely been discovered by this means. Active faults are recognized as photo-lineaments associated with characteristic tectonic features that are created by cumulative displacements along the fault traces and/or dislocations of geomorphic surfaces such as Pleistocene and Holocene fluvial or marine depositional and erosional surfaces. Lineaments such as stream courses, ridges are good reference lines for recognizing lateral displacements. Along previously recognized faults, only the portion or portions that dislocate Quaternary features and/or deposits are mapped in this study. In addition, we can only recognize active faults where young sediments or geomorphic features are present. In some cases, this means that potentially hazardous faults or fault segments will not be discovered by our approach. Further studies using different, more elaborate and costly, approaches are needed to provide a more complete hazard evaluation.

Wellman (1966) did a pioneering study using aerial photographs in a similar manner for all of southwest Asia, but was not able to publish detailed maps of his results. He recog-

nized only the major structures of the region.

Active faults were originally recorded on 1:250,000 scale toposheets and then compiled on 1:500,000 map sheets. Each map sheet is accompanied by a table containing major data about the individual faults. These maps and tabulated inventories of the active faults of Pakistan form Part II of this study. Precise locations, mode and sense of faulting, and amounts of displacement have been shown on these maps and tables. Major axes of active folding are also shown on these maps.

These active faults are related to the contemporary collision boundary between the Indian, Arabian, and Eurasian Plates, which is located in Pakistan (Figure 1). This boundary is formed of the approximately east-west Himalayan Continent/Continent Collision Zone in northern Pakistan, the approximately north-south Chaman Transform Zone through the center of the country, and the approximately east-west Makran Ocean/Continent Collision

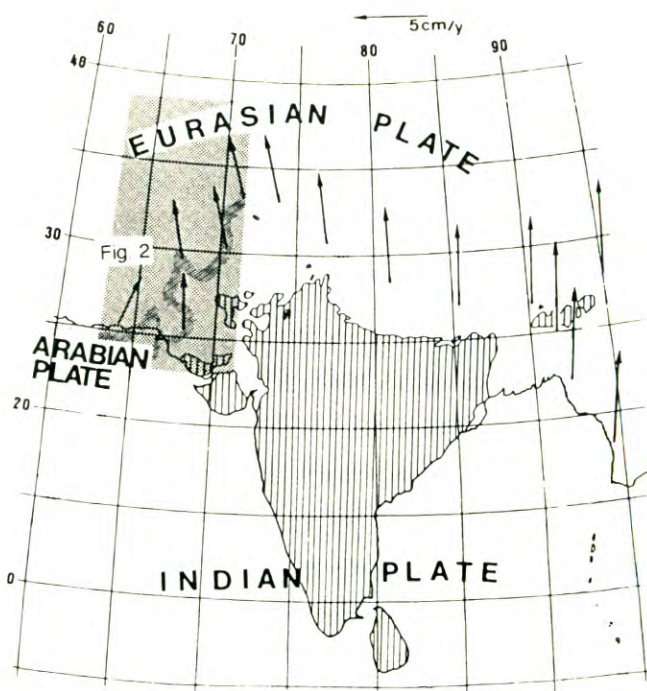


Figure 1. Overall relative motion of the Indian, Arabian, and Eurasian Plates. Arrows show motion along plate boundary calculated after Minster and Jordan (1978).

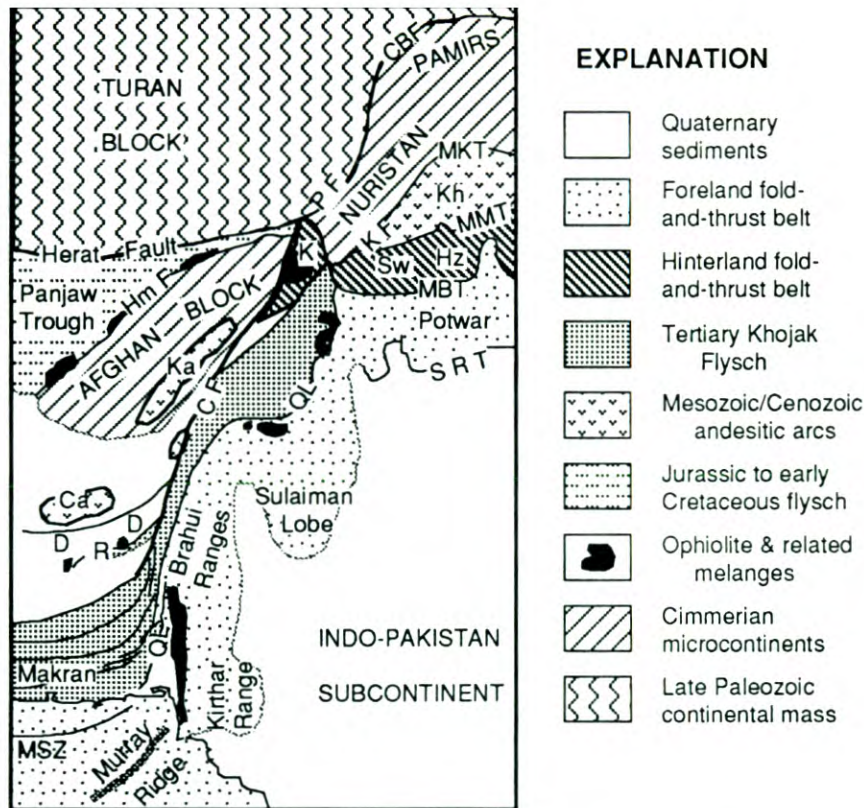


Figure 2. Major tectonic features of Pakistan area.

Abbreviations used as follows: CBF = Central Badakhshan Fault, CF = Chaman Fault, Ca = Chagai Arc, D = Dalbandin Trough, Hz = Hazara Area, Hm F = Helmund Fault, K = Kabul Block, Ka = Kandahar Arc, Kh = Kohistan Arc, K F = Kunar Fault, MBT = Main Boundary Thrust, MKT = Main Karakorum Fault, MMT = Main Mantle Thrust, MSZ = Makran Subduction Zone, P F = Panjshir Fault, QL = Quetta Line, R = Ras Koh, SRT = Salt Range Thrust, Sw = Swat Area.

Zone in southwestern Pakistan (Lawrence and others, 1981; Farah and others, 1984). Figure 2 shows the major tectonic features of this boundary. The Indo-Pakistan subcontinent has a foreland fold-and-thrust belt along its north-west margin and this belt has a metamorphic hinterland in northern Pakistan. In the Makran and along the Chaman Transform Zone deep-water marine flysch forms the Khojak Flysch Belt. The Chagai, Kandahar, and Kohistan Arcs resulted from mostly Mesozoic subduction along the southern margin of pre-collision Asia. North of these arcs is a set on micro-continental blocks developed during earlier collision episodes, and eventually the Eurasian continental mass of the Paleozoic is reached.

The maps may also be utilized for long-term earthquake prediction and the preparation of seismic hazard maps. Pioneer work on the active faults of Pakistan has been done by Kazmi (1979a,1979b). Kazmi outlined active fault systems on a regional basis and described their neotectonic significance. His Seismotectonic map at 1:2,000,000 (1979a) is the only known previous effort at a comprehensive map presentation of the type undertaken herein. The seismicity of Pakistan has been discussed by Menke and Jacob (1976), and Quittmeyer and others (1979). Our effort in this paper has been chiefly to detail the location of active fault traces based on young fault-induced topography.

2. Tabulated Inventory Headings

The tabulated inventories on the active faults are prepared for each sheet map using the following headings.

A. Fault number

Active faults found are numbered from NW to SE in each map sheet as much as possible, and letters are given to independent fault traces within a single named structure.

B. Name of fault

Active faults are named following the names of geological faults if previously known, otherwise newly named taking location names nearby.

C. Class

Photo-interpretation of fault activity varies in the certainty of the result. Where offset streams are documented, Holocene activity is clear, but where the interpretation relies inferences about the ages of young sediments the result is more dubious. Accordingly, active faults are classified herein into three certainty classes: I (definitely active), II (probably active) and III (possibly active), which record our judgment of the probability of recent displacement. However, only the clearest active faults within certainty class III are shown on the map.

D. Activity

The average slip rate of an active fault is also an important measure of its potential hazard. We have defined three activity classes: A, B and C, according to presume slip-rates. Activity 'A' indicates that a fault has moved at the rate of more than 1 m per 1,000 years, 'B' between 0.1 to 1 m per 1,000 years, and 'C' less

than 0.1 m per 1,000 years. The quality of the activity data varies with the type of information present on the aerial photographs that provide the basis of the measurement.

E. Length

Length is measured in kilometers for each fault within each map sheet. Where the fault continues onto adjacent sheets the length is in brackets and refers only to the length on the particular sheet. Total length for such faults is given in the remarks column.

F. Strike

The average strike of the fault.

G. Fault features

These are the features observed on the aerial photographs that were created by the fault(s). They are largely developed in Quaternary materials. Abbreviated letters for fault features are used as follows:

FS:	Fault Scarp
RS:	Reverse Scarp
Ho:	Horst
Gr:	Graben
Wa:	Warping of young surfaces
Ti:	Tilting of young surfaces
LV:	Linear Valley
SO:	Stream Offset
PR:	Pressure Ridge
SR:	Shatter Ridge
TC:	Tension Crack
Sg:	Sag
Li:	Lineament

H. Fault reference

These are the Quaternary features affected by the fault that allow it to be interpreted as active. Abbreviated letters are used as follows:

PF:	Pleistocene Fan
HF:	Holocene Fan
PMT:	Pleistocene Marine Terrace
FgT:	Fluvio-glacial Terrace
RT:	River Terrace of unknown age
PT:	Pleistocene Terrace of unknown origin
HT:	Holocene Terrace of unknown origin
V:	Valley
St:	Stream
RB:	River Bed
Mo:	Mountain
MS:	Mountain Slope
HS:	Hill Slope
Ri:	Ridge
h:	higher
m:	middle
l:	lower

I. Vertical displacement

The vertical displacement, interpreted on the basis of the fault features, is given in meters. Letters indicate the upthrown side of fault by geographic position, that is, N = north, SE = southeast, etc. In those cases where the displaced surfaces are well-defined, the displacements on each level of the surfaces are shown in brackets. Abbreviations for the displaced surface are the same as under *H* above. The displacements given are cumulative, that is, the amount for the higher surface will include the amount for the lower surface.

J. Lateral displacement

In the case of strike-slip faults, the displacement is shown in meters with letters that indicate the sense of slip (R = right-lateral and L = left-lateral).

K. Remarks

This column contains additional information. Total fault length in kilometers is given here. Where the fault appears on several map sheets, the other sheet numbers and fault numbers on those sheets are noted here.

3. Summary Description of Active Faults

Figure 3 shows the locations of the summary maps of the locations of active, surface-breaking faults in Pakistan, which are used below to summarize briefly the distribution of these structures. Neotectonic activity takes a variety of forms. In this study active faults have been recognized on the basis of the study of aerial photographs, previous publications, and personal field experience. In every case a feature must displace young geomorphic features and/or depositional surfaces in order to meet our criteria for being active. Major faults may exist below the surface on which recent motion has occurred. These features will not be recognized by the techniques we have used. It is important to recognize this limitation, since neotectonic features are of great importance for evaluating earthquake hazard. The features discussed herein are a subset of those which produce an earthquake hazard. This kind of study can suggest that places where numerous active, surface-breaking faults has a significant seismic hazard. However, places without such faults cannot be said to be without hazard as blind faults or deep faults, which intersect the surface at a very low angle, may produce a hazard that is not related to local surface features.

A. Northern Region

Figure 4 shows the distribution of active faults in the area north of the Kohat and Islamabad. Our detailed photo-interpretation studies indicate that active faults are scarce in the mountainous areas north of Peshawar and Muzaffarabad, that is, north of the Main Mantle Thrust (MMT). On the other hand, the same area has moderately high level of seismicity (Quittmeyer and others, 1979). Much of this seismicity is probably localized on deep detachment surfaces that emerge to the south as

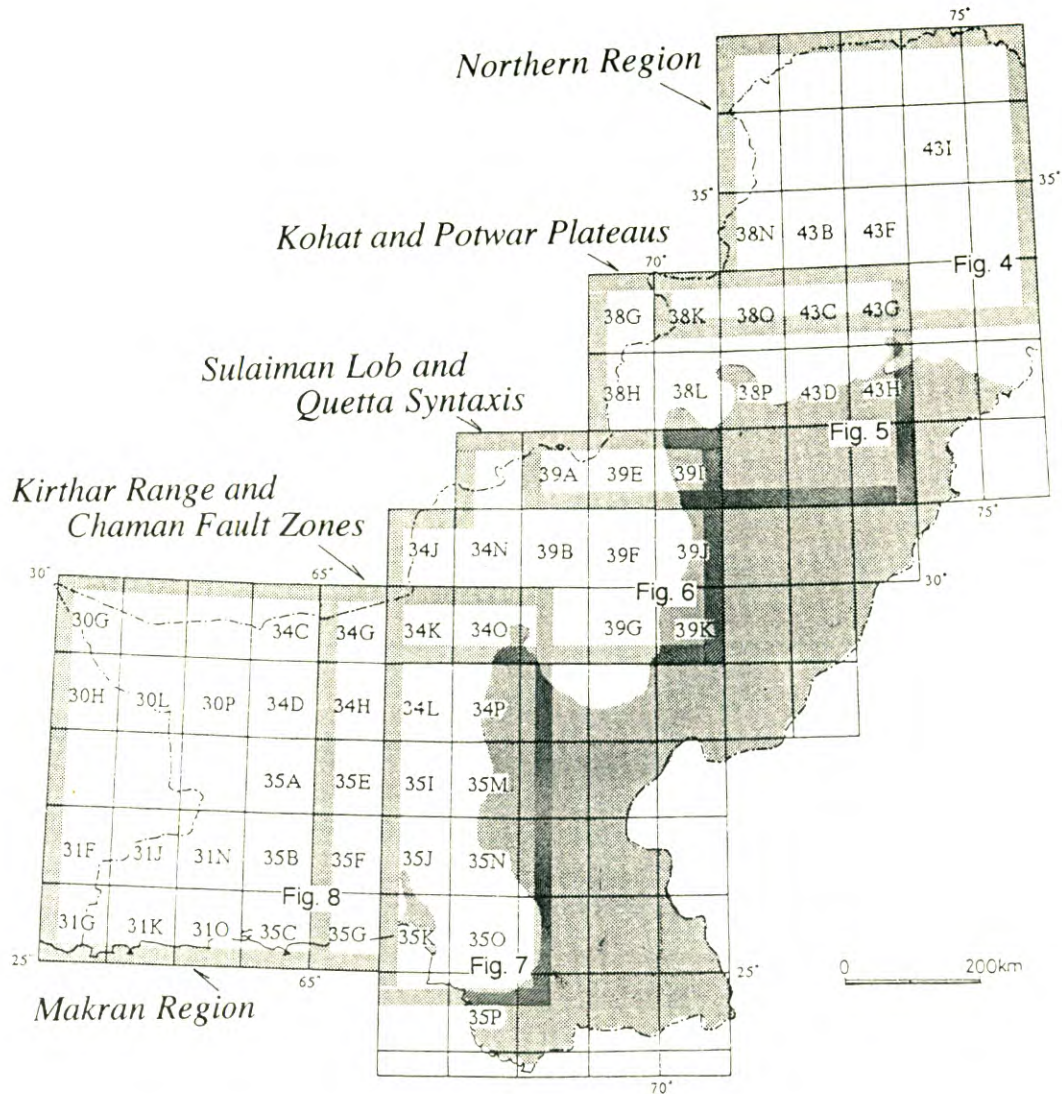


Figure 3. Location of active fault summary maps shown in Figures 4 through 8. Each one degree map sheet which has active faults and is present in Part 2 is shown by its designator.

the Himalayan foreland thrust system. The active surface faults that express this motion are mainly located south of the MMT. The Raikot Fault along the west margin of the Nanga Parbat-Haramosh Massif is the major exception (Misch, 1936; 1950; Lawrence and Ghauri; 1983; Yeats and Lawrence, 1984; Lawrence and Shroder, 1984; Madin and others, 1989; and Shroder and others, 1989).

Active faults are rather densely distributed on and near the Main Boundary Thrust

(MBT) along the southern portion of Figure 4. E-W trending dip-slip faults are well developed to the west of Parachinar, probably on the MBT. In the southern part of the Peshawar Basin, the active Manki Fault (Yeats and Hussain, 1987, 1989) exhibits a series of active ENE-WSW traces with dip-slip south-side down motion. In the Hazara-Kashmir Syntaxis, N-S trending dip-slip active faults have been found near Muzaffarabad.

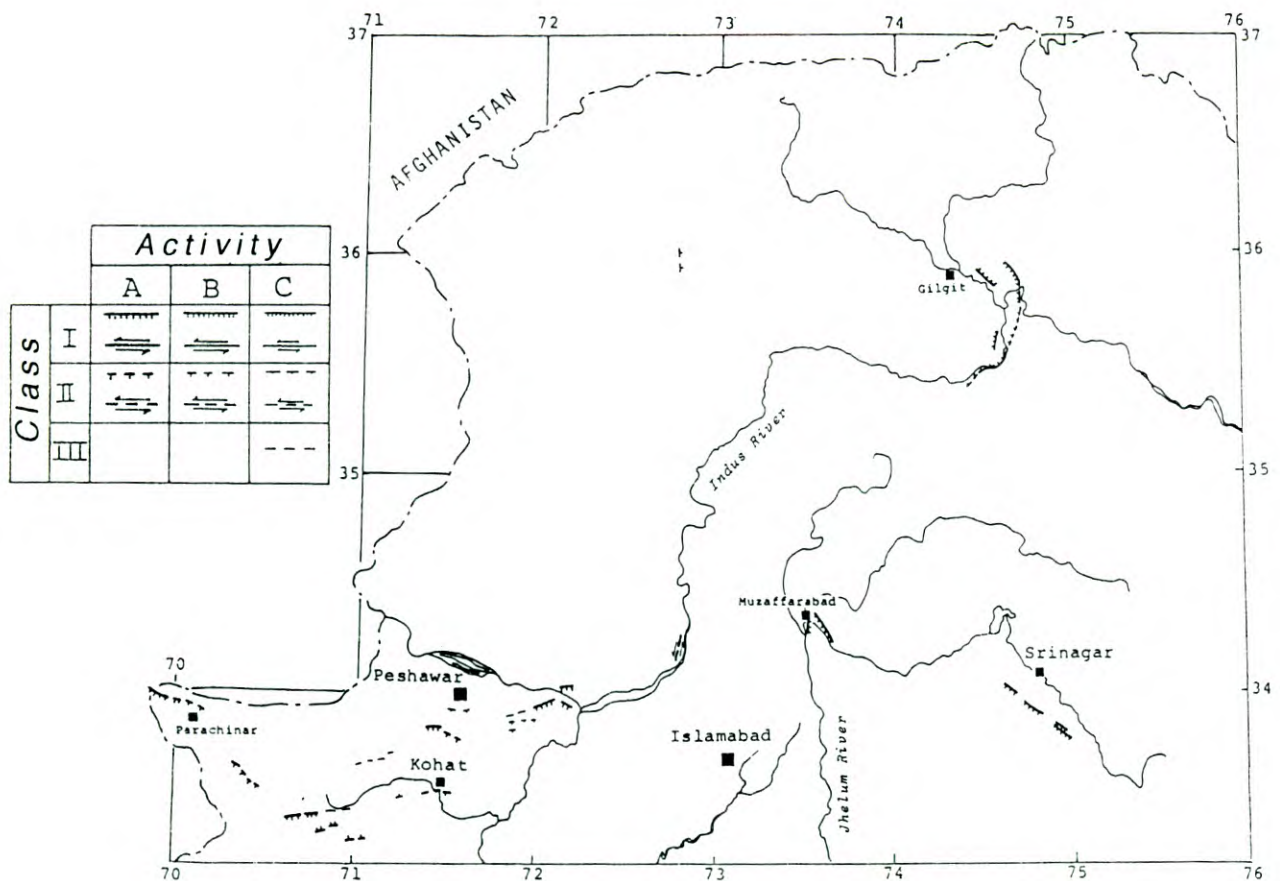


Figure 4. Active faults of the Northern Region of Pakistan.

Northwest of Islamabad along Tarbela Reservoir, active faults trending N-S have been recognized. Ahmad (1971) first reported active faults in this area and related seismicity has been reported by Armbruster and others (1978) and Seeber and others (1980).

The structure southwest of Srinagar is on the south side of the Vale of Kashmir north of the MBT. Burbank (1982) has discussed young structures in the Kashmir intermontane basin, but not in the same place as the feature mapped here.

B. Kohat and Potwar Plateaus

Figure 5 shows the distribution of active faults in and around the Kohat and Potwar Plateaus (De Jong, 1986). The most important fault in this area is the Salt Range Front Fault, which is the active leading edge of the Himalayan thrust system (Baker and others, 1988;

Lillie and others, 1987) Topographical evidence for active faulting is not clearly observed along the Salt Range Front, although certain geological evidences of Quaternary faulting have been found (Yeats and others, 1984). This largely reflects the low angle fault plane of this feature that produces a very irregular surface trace. Steeply dipping active faults produce straight traces that clearly offset geomorphic features. On the other hand, E-W trending dip-slip faults are rather densely distributed in some parts of the Kohat Plateau and Surghar Range. Dip-slip faults in N-S direction are also found to the west of Bannu.

Among the geological strike-slip faults on the flanks of the Salt Range and the Trans-Indus Salt Range, active faults of right-lateral sense appear only along the western flank of the Salt Range (McDougall and Khan, 1990). The western termination of the Salt Range Thrust Block occurs along this Kalabagh Fault. In contrast, no strike-slip zone is discernible

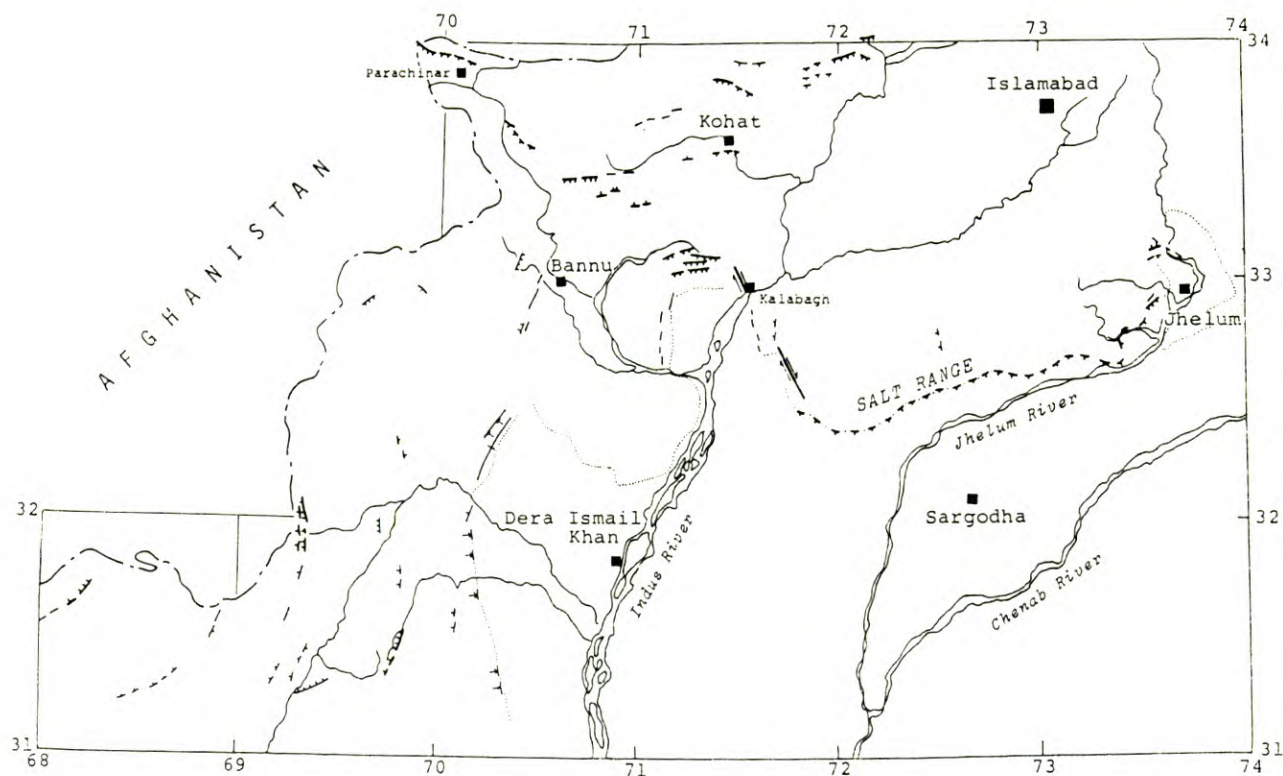


Figure 5. Active faults of the the Kohat and Potwar Plateaus and vicinity. Legend is the same as on Figure 4.

on the eastern flank.

Southwest of the Trans-Indus Salt Range and west of Dera Ismail Khan, N-S trending active faults and active anticlinal axes are found along the eastern part of the Sulaiman Range. However, it is noteworthy that these active structures do not always occur along geologically known faults of the same trend.

C. Sulaiman Lobe and Quetta Syntaxis

North-northeast trending structures west and north of Quetta are part of the Chaman Transform Zone (Lawrence and others, 1981). The portion of the Chaman Fault in the Chaman area has numerous outstanding neotectonic features related to left-lateral strike-slip faulting (Lawrence and Yeats, 1979; Khan and others, in press). East of the Chaman Fault and north of Muslimbagh a series of faults whose certainty class is low are recognized (Figure 6). These occur in the Khojak Flysch Belt, and

they are distributed along major geological thrust faults within the flysch. Faults are clearly present, but it is difficult to find conclusive features that document recent motion. North of Quetta and Muslimbagh another set of faults has a high certainty of documented activity. These structures are along the complex of structures that separates the flysch belt from the Indian shelf sediments of the Sulaiman Lobe (Khan and others, in press). Part of these structures first formed in the Paleocene during ophiolite emplacement (Allemann, 1979), but are now clearly active. The structures south of Quetta will be discussed in the next section.

Active dip-slip faults with various strikes are widely distributed in the southward convex structural trends of the Sulaiman Lobe and Quetta Syntaxis (Figure 6). This zone is characterized by the highest level of seismic activity in Pakistan (Quittmeyer and others, 1979). Active faults around Muslimbagh generally trend E-W, while those east of Loralai gradu-

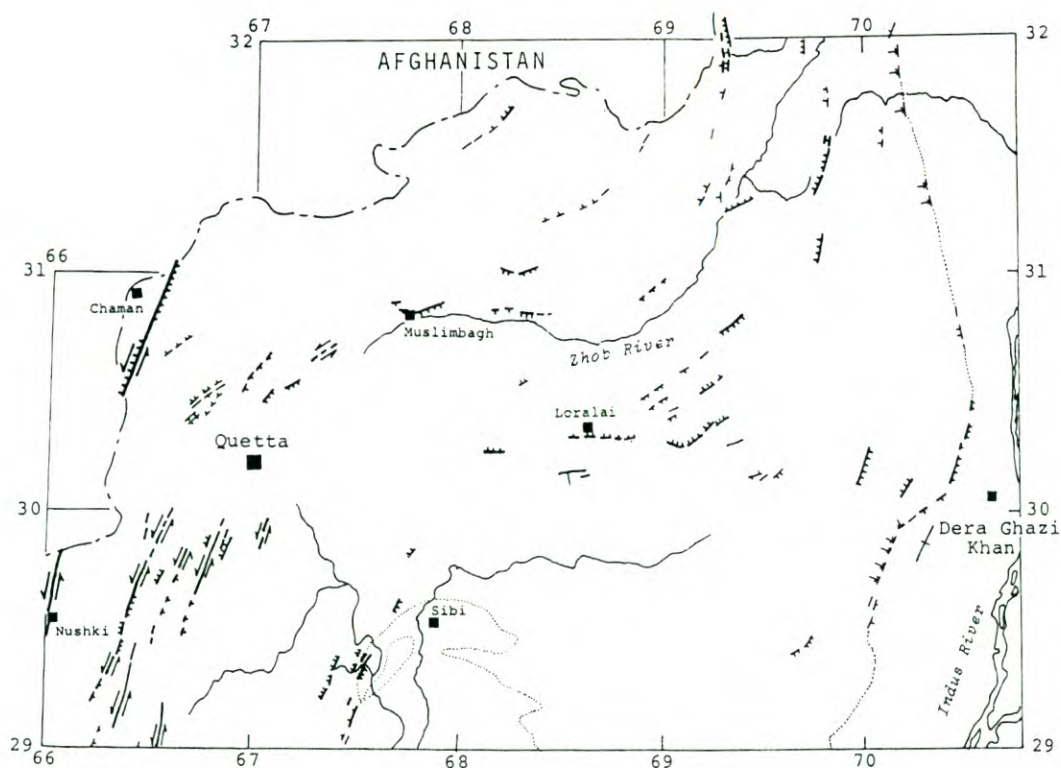


Figure 6. Active faults of the Sulaiman Lobe and Quetta Syntaxis. Legend is the same as on Figure 4.

ally change their strikes to northeasterly accurately conforming to structural trends of the northern Sulaiman Lobe. The eastern fringe of the Sulaiman Lobe is demarcated by N-S trending active faults or active folding with an N-S axis (Humayon and others, 1991). Active faults are more densely distributed within the fold-and-thrust belt composed of Mesozoic and Tertiary sedimentary rocks. Some of the active faulting has been taking place during flexural slip along bedding planes on the flanks of active anticlinal folds. Previous workers have suggested major active strike-slip faults along the eastern and western margins of the Sulaiman Lobe (Abdel-Gawad, 1971; Rowlands, 1978). However, we found no active lateral slip faults that displaced Quaternary features or sediments. Not even the Kingri Fault located northwest of Dera Ghazi Khan displaces Quaternary features detectably on air photos. The southern part of the Sulaiman Range, underlain by an active thrust system

(Jadoon and others, in press), is characterized by scanty active faulting at the surface. The southernmost folds of the Sulaiman Lobe that overlie the thrust system are probably actively growing, but do not show fold-related active faulting on their limbs.

D. Kirthar Range and Chaman Fault Zones

Active faults of N-S trend are abundant in this region (Figure 7). The clearest active fault traces with the most evident neotectonic features are found along the Chaman Fault. The Chaman Fault is a major left-lateral fault forming part of a plate boundary, and information about its geotectonic significance is available in numerous publications (Griesbach, 1893, Hunting Survey Corporation, 1960, Wellman, 1966, Lawrence and Yeats, 1979, Kazmi, 1979b, and Khan and others, in press). Major activity

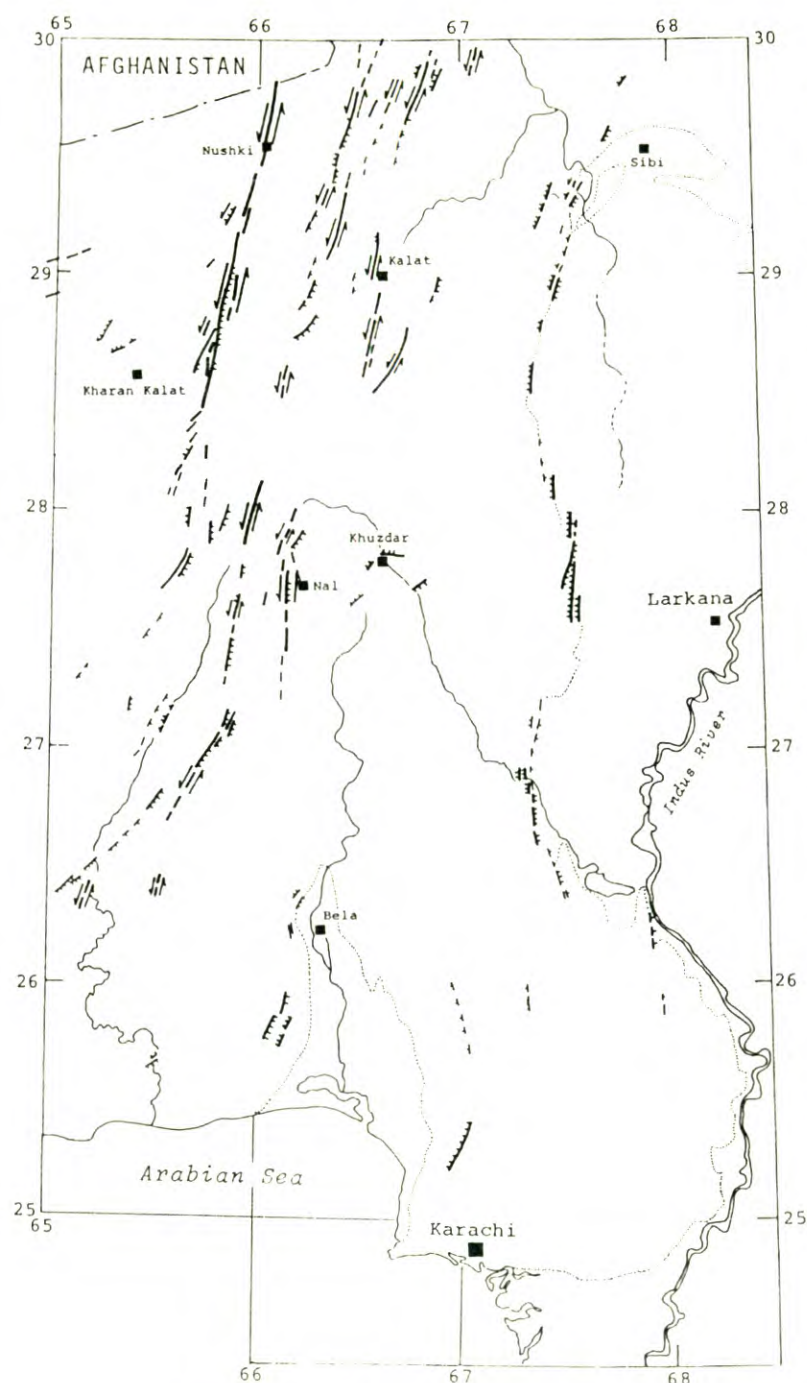


Figure 7. Active faults of the Kirthar Range and Chaman Fault Zone. Legend is the same as on Figure 4.

Parallel to the Chaman Fault, several lateral-slip faults have been found in the zone 80 km wide. Sense of the left-lateral strike-slip is commonly recognized along these faults. They occur on the eastern margin of the flysch zone, that is, on the Ghazaband Fault, and in folded and faulted Mesozoic rocks of the Indian Shelf. Active faulting is also distinct along the northern part of Ornach-Nal Fault.

Along the Kirthar Range Front, south of Sibi, N-S trending active faults are rather continuously distributed. They are of dip-slip origin and some of them are bedding plane faults on the limbs of active anticlinal structures. The structural development of this zone has been discussed by Banks and Warburton (1986).

Along the southern part of Pab Fault, active traces dislocate younger Pleistocene fan surfaces vertically. No lateral displacement has been recorded along these active traces although Pab Fault extends Parallel to the Chaman and Ornach-Nal Faults. These structures are in the rear of the Kirthar Thrust Lobe.

E. Makran Region

The distribution of active faults in the Makran region is shown in Figure 8. In the eastern part of the region, NE-SW striking active faults rotate from E-W in the west to join major strike-slip faults of the Chaman Fault System to the east. In this portion, the geological faults are expected to be oblique slip (Lawrence and others, 1981), but the active traces are mostly upthrown to the north with no distinct left-lateral displacements.

The western half of the region is mainly

along the fault traces is consistently left-lateral while sense of vertical displacement changes from place to place. The apparent downthrown side is to the east based on geomorphic evidence along the southern part of the fault, but uplifted flysch and paleo-erosion surfaces show major opposite displacement in the slightly earlier past (Khan and others, in press).

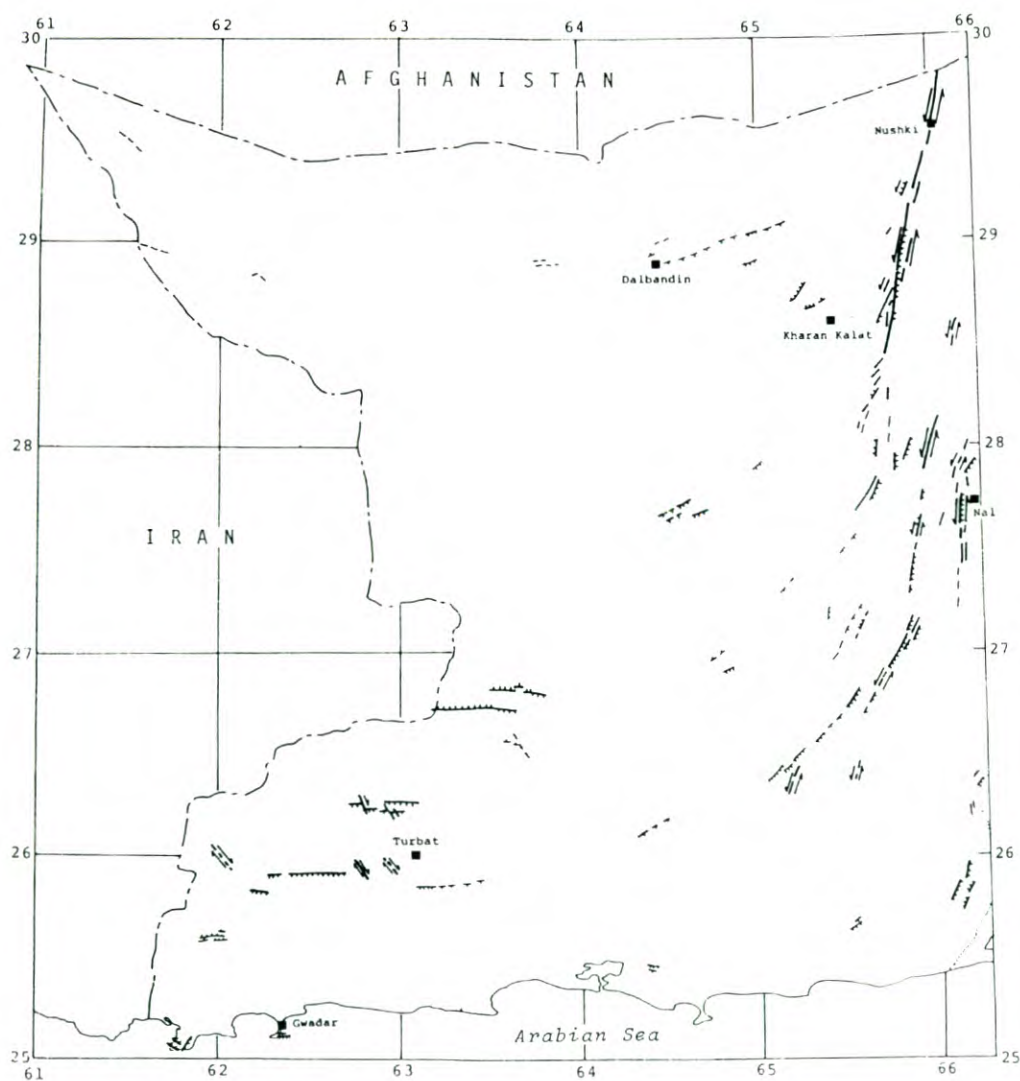


Figure 8. Active faults of the Makran Region. Legend is the same as on Figure 4.

occupied by E-W trending dip-slip faults. Sense of vertical displacement along these faults is generally up to the north. This is appropriate to interpreting them as elements of the thrust system of the Makran Flysch Belt (Jacob and Quittmeyer, 1979; Farah and others, 1984). They are in places cut by short NW-SE trending faults. These are probably conjugate strike-slip fault sets related to folding in the Makran. Several short active faults trending in different directions cut marine terraces on the Makran Coast (Page and others, 1979). Mud volcanoes are abundant in the southern Makran, both on and off shore (Hunting Survey Corporation, 1960; Snead, 1964), and these are probably related to neotectonic processes.

4. Active Fault Density Distribution

In order to examine the regional characteristics of the distribution of active faults, an active fault density map has been prepared (Figure 9). Total length of active fault traces in every half a degree quadrangle has been calculated. Density is shown by total fault length per degree quadrangle at every half degree intersection and density contours are drawn at every 50 km interval. The highest density area lies in the zone where left-lateral strike-slip faults are common. This most densely faulted area is located along the Chaman Fault Zone and its maximum density is 400 km per 1 de-

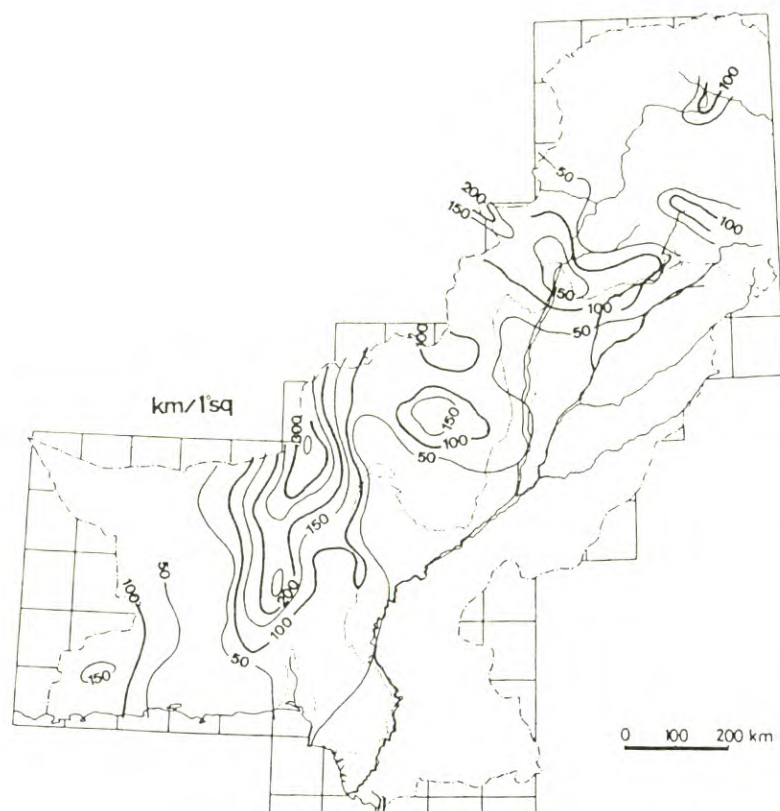


Figure 9. Density of active faults in Pakistan contoured as length of active fault per one degree quadrangle.

and related faults south of Quetta, neotectonic features reflecting left-lateral displacement are widely recognized. Note that active left-lateral strike-slip faults east of the plate boundary occur only south of Quetta (Figure 7) except one probable trace between Quetta and Muslimbagh, another probable trace north of Tarbela (Figure 5), and the Raikot Fault north of Nanga Parbat (Figure 4). Active right-lateral faults are rare in Pakistan; one significant fault - the Kalabagh Fault is located on the western flank of the Salt Range. Thus strike-slip faults are mainly developed along the transform plate boundary between the continental Indian Plate on the east and the continental Afghan Block and oceanic Makran Zone. The curved trends of the syntaxis east and north-east of Quetta record complications in the transition from this

transform motion to dip-slip thrust deformation above the continental Indian plate margins.

gree square near Nushki. In contrast, the areas of dip-slip faulting do not have such high fault densities. However, zones of relatively high density lie in the Sibi area east of the Chaman Fault, in the Sulaiman Lobe, and in the Himalayan Frontal Thrust Zone. In the Himalayan Ranges, isolated areas of high fault density are found in Kashmir Valley and southeast of Gilgit. No active faults have so far been found in the Indus Plain area.

5. Mode and Sense of Active Faulting and Their Regional Disparity

There are meaningful patterns in the mode and sense of displacement along the active faults of Pakistan. Strike-slip and thrust faults are the only common fault modes observed.

Along the NNE-SSW extending active traces of the Chaman and Ornach-Nal Faults

East-west trending active faults in the Kohat and Potwar Plateaus, the Salt Range Front, the Sulaiman Range and the Makran region, are characterized by dip-slip faulting, mainly in thrust systems. Dip-slip displacement is also predominant along the N-S extending active faults along the Sulaiman Range and Kirthar Range Fronts. The same type of faulting is observed along some of bedding planes on the limbs of active flexural slip anticlinal structures (Yeats, 1986). One interesting feature is that, in many places, Quaternary gravel on the eastern front of the Sulaiman Range shows considerable tilting toward the east. This is inferred to be related to tectonic deformation. Analogous features are present on the eastern front of the Kirthar Range.

6. Stress Axes Deduced from Active Faulting

The current direction of maximum horizontal shortening or maximum horizontal principal stress can be determined from active faults (Research Group for Active Fault, Japan, 1980). Figure 10 shows the stress axes deduced from active faulting and folding. Mode and sense of faulting are consistent with compressive stress axes created by drift of the Indian Plate against the Asian Plate. Strike-slip displacement along NNE-SSW and NNW-SSE extending faults and dip-slip displacement along the E-W extending faults reflects the accommodation of this motion in surficial rocks. However, sense and mode of active faulting along the Sulaiman and Kirthar Range Fronts imply maximum horizontal principal stress in E-W direction, which is discordant to the general stress field created by relative motion between Eurasian and Indian Plates (Figure 1). The slip vectors of Arabian and Indian Plates with respect to Eurasian Plate at triple junction have been determined by Jacob and Quittmeyer (1979). The small difference between the strike of the transform boundary and the resultant direction of motion of the Indian Plate creates a small com-

ponent of convergence. Thus the Chaman Transform Zone is transpressional (Khan and others, in press) and causes east-west compression across the Sulaiman-Kirthar Ranges. This suggests that the surficial rocks of the Indian margin are decoupled from the underlying crystalline plate along the western Indian margin.

7. Active Faults and Seismicity

The seismicity of Pakistan is relatively high with numerous earthquakes of magnitudes less than 6.5, and no large earthquakes that were associated with surface ruptures have occurred during the last two decades. Quittmeyer and others (1979) examined and discussed on the relationship between faults and contemporary seismicity. They classified present earthquakes into three categories: major earthquakes associated with known faults, narrow, elongated zones of earthquakes less clearly related to faulting, and diffuse activity not clearly related to any individual fault. The third category is probably commonly related to low angle faults, on which earthquakes occur with little direct relation to the surface expression of the structure.

This study has greatly increased the data base of known, surface-breaking, active faults, providing the basis for a substantial refinement of previous studies. To examine the relation between these faults and earthquakes, we prepared maps showing intensity contours for large historical earthquakes (Quittmeyer and others, 1979) on our active fault map (Figure 11), and also maps of epicenters of earthquakes shallower than 100 km between 1971 to 1985 based on the International Seismological Centre Bulletin. The latter are shown on as three separated layers (0 - 20, 20 - 60, and 60 - 100 km depth) with earthquake epicenters of magnitudes ≥ 4.0 classified by 0.5 M intervals (Figures 12 - 14).

In spite of the long, rich history of the region, known historical records on destruc-

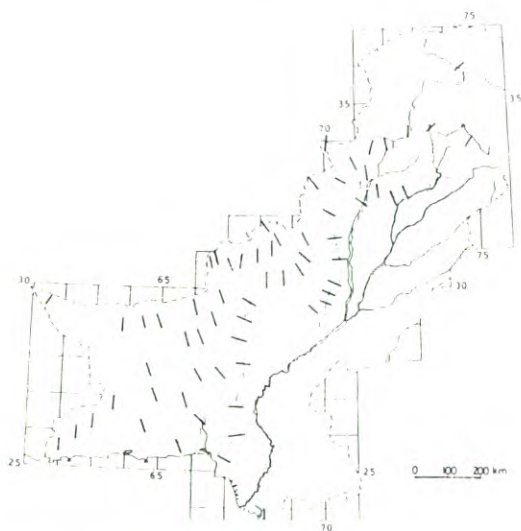


Figure 10. Stress axes in Pakistan deduced from active faulting and folding.

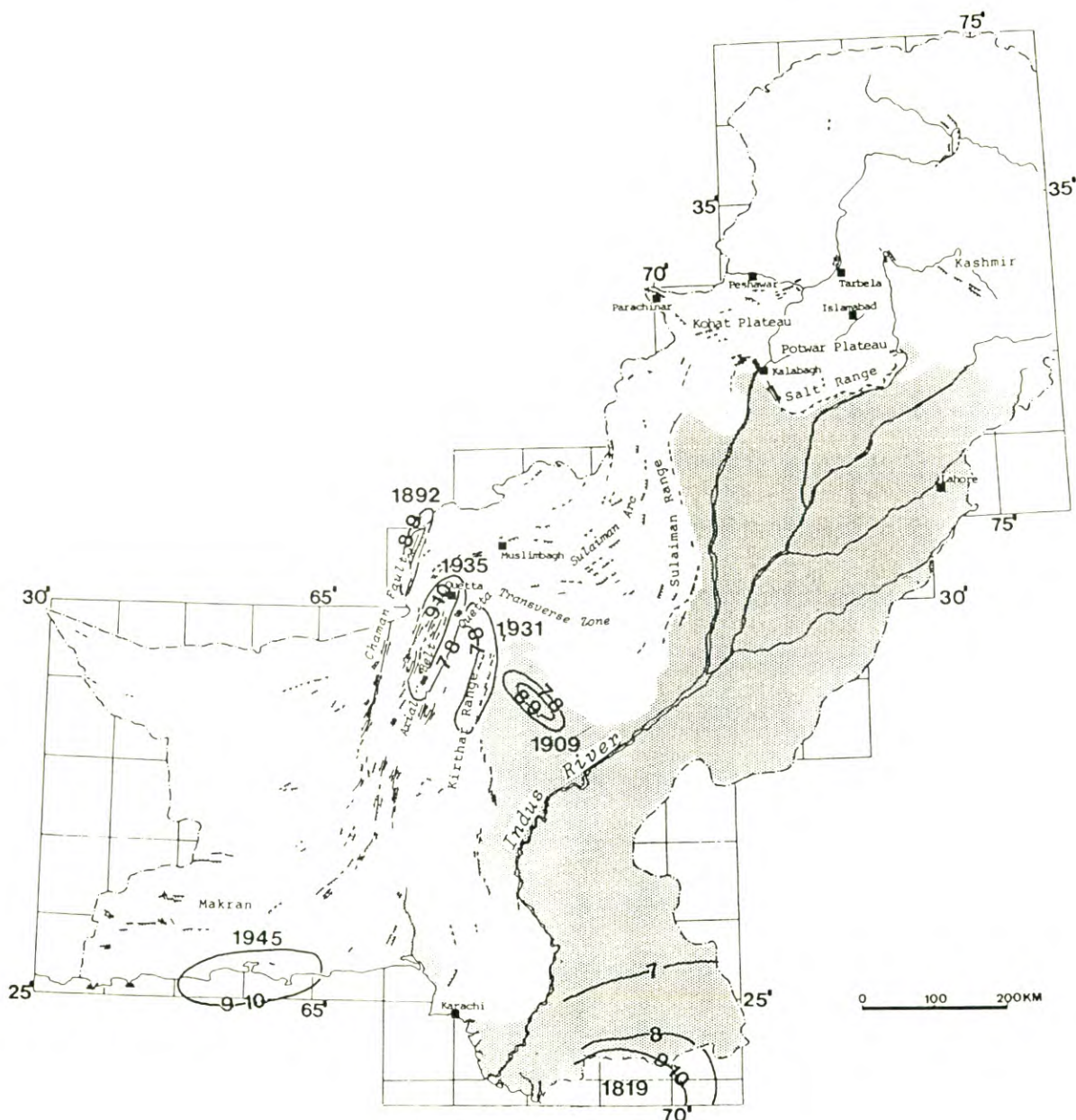


Figure 11. Summary active fault map of Pakistan showing major historic earthquakes by intensity contours (contours after Quittmeyer and others, 1979).

tive earthquakes associated with surface faulting before instrumental records are few (Oldham, 1882; Quittmeyer and others, 1979). However, some large historical earthquakes seem to have been generated by the active faults mapped in this study (Figure 11). The Chaman Earthquake of 1892 was associated with surface displacement along the segment of the fault near Chaman (Griesbach, 1893). Left-lateral strike-slip of about 0.75 m was measured from offset of railway tracks, streams

and ridges. In 1931, a large earthquake ($M_s = 7.4$) occurred also the northeastern fringe of the Kirthar Range where many bedding plane faults are developed (West, 1934). It is, however, not known whether any surface rupture along these faults took place at the time of the earthquake. The Quetta Earthquake of 1935 ($M_s = 7.5$) had a rupture length of 150 km (West, 1935; Skrine, 1936; Quittmeyer and others, 1979; Singh and Gupta, 1980; Armbruster and others, 1980). Though there are numbers

of distinctive active faults of strike-slip type are distributed in the epicentral area, it is not yet clear which particular fault caused the earthquake and if any surface faulting was associated with it. Other major events were the earthquake of Rann of Kutch in 1819 (Oldham, 1926) and the one ($M_s = 8.0$) off the Makran Coast in November 1945 (Sondhi, 1947). The former one is believed to have caused vertical displacement of 7-9 m along the E-W extending fault north of the Rann of Kutch (Oldham, 1926), but little is known about the active faults in the area. The latter one generated a tsunami and caused uplift of the coast of about 2 m (Geller and Kanamori, 1977; Page and others, 1979). Though it is presumed that the earthquake was produced by activity on one of the E-W trending thrust faults off the coast, similar to the active faults in the Makran region, little is known about active faults in the sea-floor part of the area. One event that took place in 1909 was located near Sibi in the Indus Plain where no surface faults have been mapped (Heron, 1911).

Present seismicity shallower than 20 km deep in the crust is characterized by rather concentrated distribution of epicenters (Figure 12). Earthquakes in this layer are mostly smaller than magnitude 5.0 so that they could be produced by small fault movements, and as the result they are not easily related to surface faults although they are shallow seated. A rather heavy concentration of epicenters is found on the northeast side of the Quetta Syntaxis where no active faults have been mapped. The Sulaiman Lobe is, however, an active thrust structure; probably with blind thrust faults. The eastern margin of the Sulaiman Range is a zone of active folding and related faulting, and the seismicity along the margin is probably closely related to this ac-

tivity. Other epicenters except for the ones along the Chaman Fault and along Sulaiman Range Front, are scattered in areas where no active faults have been found. A linear alignment of epicenters along the Chaman Fault is located south of the 1892 earthquake area and shows the activity of the 1978 earthquake ($M = 5.2$) near Nushki (Yeats and others, 1979) and its associates. This may indicate increasing activity on the Chaman Fault.

In Layer 2, seismicity is more diffused, yet epicenters are distributed in areas with no active faults (Figure 13). A large concentration of epicenters exists in the area from the Quetta Syntaxis to the central and southern parts of the Sulaiman Lobe where development of active surface faults is very poor (Quittmeyer and Kafka, 1984). Along the Chaman Fault

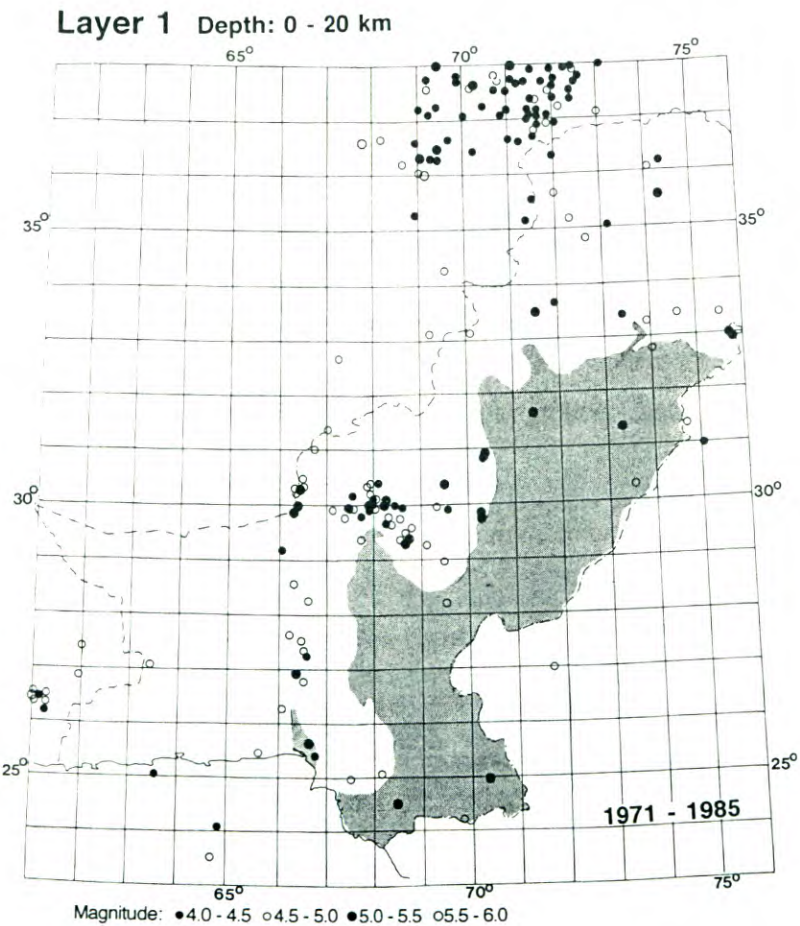


Figure 12. Distribution of shallow (0-20 km) earthquake epicenters in Pakistan and vicinity.

between Chaman and Nushki, seismicity is also rather high in this layer. In the Axial Belt, epicenters are distributed east of the active fault zone, and the areas of large historical earthquakes are devoid of present seismicity. In the mountain area north of the Main Boundary Thrust earthquakes as large as magnitude 6.0 - 6.5 are distributed widely and are hard to relate to individual active faults. Some of them may be main and after-shocks of the Pattan Earthquake of 1974 ($M = 6.0$) which did not produce any surface break (Pennington, 1979, Jackson and Yielding, 1983). Few of the earthquakes in this layer are closely related to active faults.

In Layer 3, most earthquakes occurred in areas without active faults (Figure 14). They are deep-seated, smaller than magnitude 6.0, and are not related to surface faulting.

We conclude that the large historical earthquakes are closely related to active faults, but that most of active faults are seismically quiet except at the time of great earthquakes. The Chaman Fault is the principal structure with reasonably frequent earthquakes along it of smaller magnitude. Much of the current faulting probably relates to thrust faults at depth whose surface expression bares no direct tie to the epicenters of the events. Contemporary seismic activities in Pakistan are mainly related to minor subsurface faulting and they are hard to relate to surface faulting.

8. Summary and conclusion

Air photo interpretation has revealed many unknown active faults throughout Pakistan; they reflect the nature of Recent and Subrecent tectonic conditions of the colliding plate boundary in Pakistan. Field follow-ups and dating of displaced sediments along the active faults will provide slip-rates in various tectonic zones during Quaternary than are available from this study. Practical use can be made of the data for long term earthquake predictions, and the maps may therefore, be consulted where and when seismic risk studies are carried out.

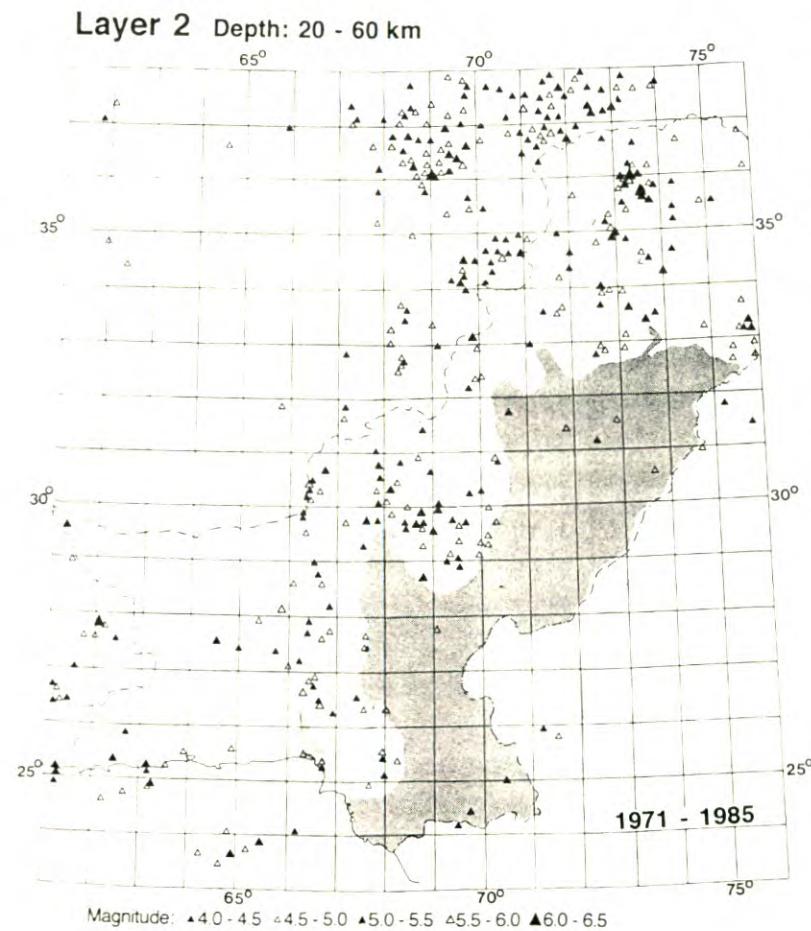


Figure 13. Distribution of intermediate (20-60 km) earthquake epicenters in Pakistan and vicinity.

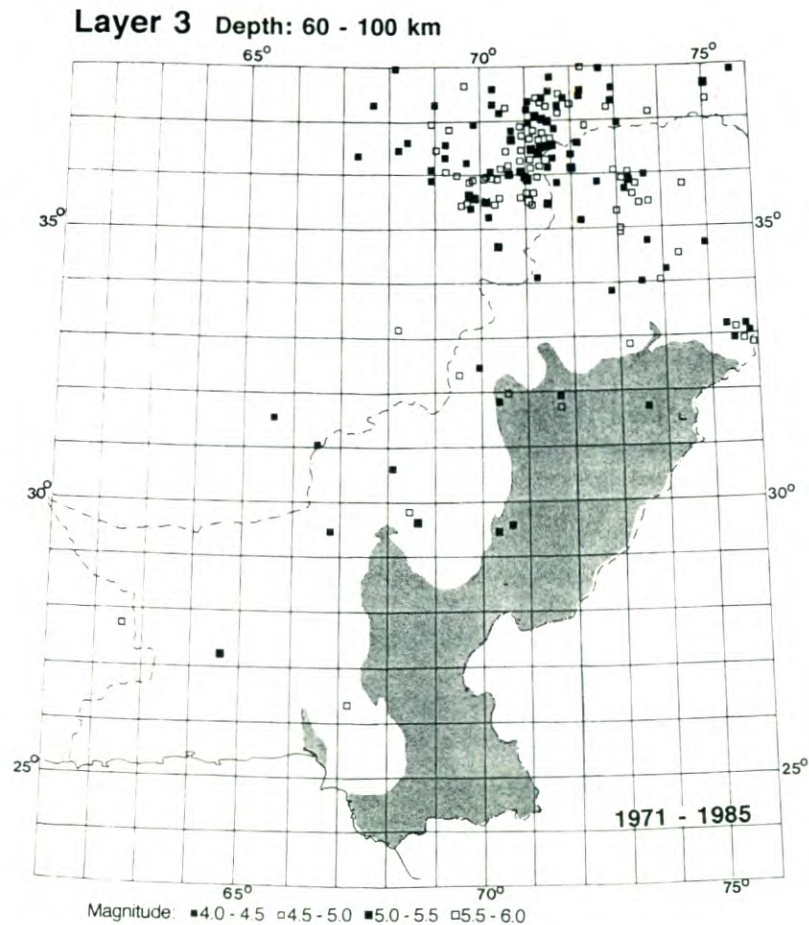


Figure 14. Distribution of deep (60-100 km) earthquake epicenters in Pakistan and vicinity.

9. Acknowledgments

This work has been carried out as a part of collaborative project among Hiroshima University, the Geological Survey of Pakistan and Oregon State University. We appreciate the effort of Robert Yeats who made it possible for both Nakata and Lawrence to begin work in Pakistan and has discussed active fault matters with both of us over a number of years. The authors are grateful to Dr. A. N. Fatmi, then Deputy Director General of Geological Survey and Professor Y. Okimura of Hiroshima University for their support in the progress of this work. Miss Yoshiko Yamanaka of Earthquake Research Institute, University of Tokyo kindly processed ISC data for this work. We

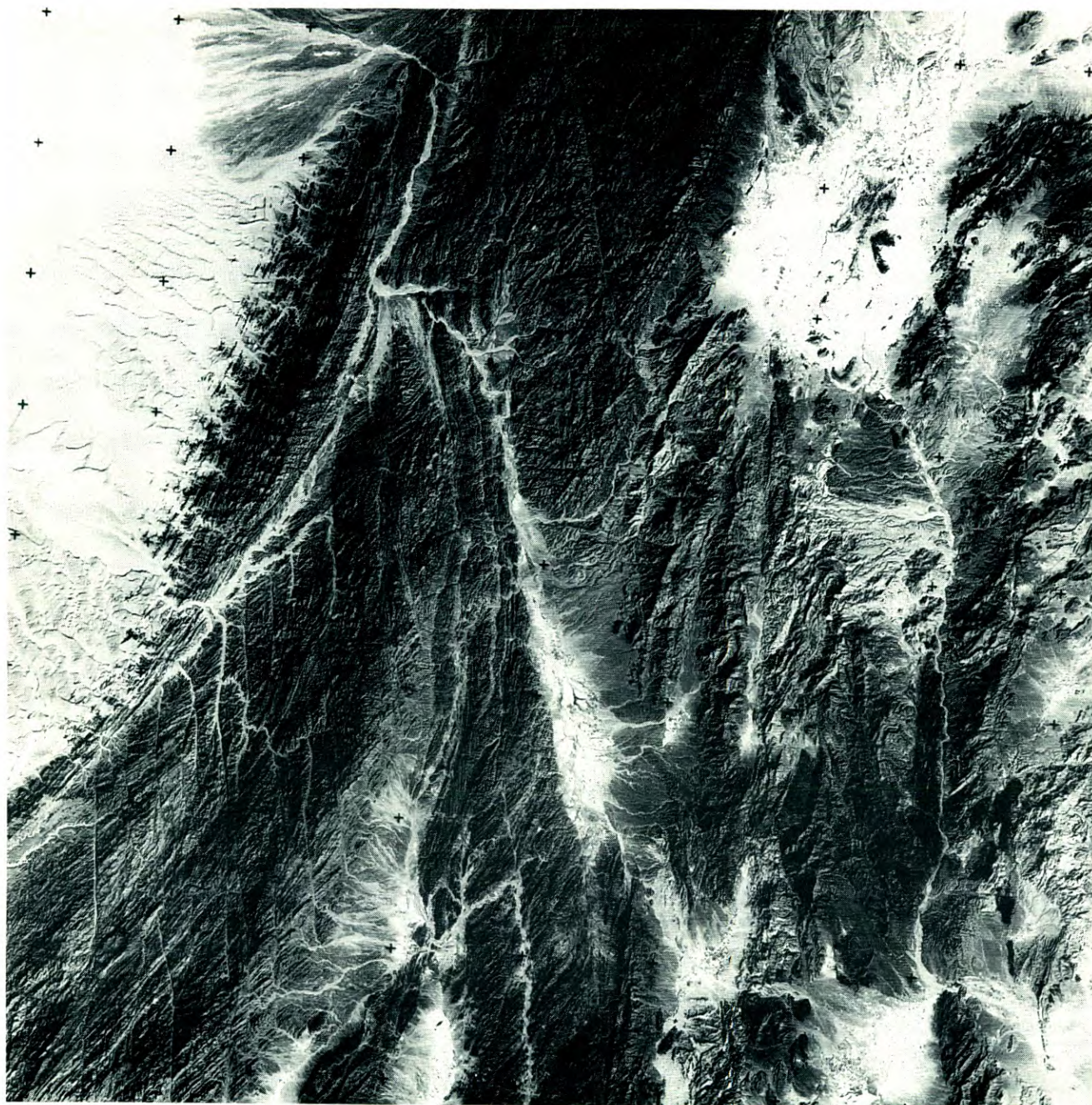
thank Professor K. Fujiwara, Director of Research Center for Regional Geography who published this volume as a Special Publication of the center. This work was partly supported by a grant for collaborative field work between Hiroshima University and the Geological Survey of Pakistan from the Ministry of Education, Science and Culture, Government of Japan, entitled Tectonics and Sedimentation of Colliding Plate Boundary in Pakistan. Lawrence acknowledges support from Fulbright scholarships, and grants from NASA and NSF that provided him with experience with many of the structures discussed. Lawrence and Nakata appreciate the support and patience of their wives and families during this effort.

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Frontpiece. Landsat image of the southern end of the Chaman Fault and geological structures in the vicinity (see map sheet 35E). The Chaman Fault ends near the northern edge of the image at Tuscan Pass where it curves to the west and becomes part of the Siahhan Thrust. The southern end of the Ghazaband Fault also ends near the northern edge of the image, east of the Chaman Fault. Numerous active faults are present in the southeastern portion of the image and can be detected by sharp traces which offset Quaternary sediments. The northern end of the Ornach-Nal Fault is in this area. Landsat RBV frame 30267-05270-A.

Part II

Catalog

of

Active Faults

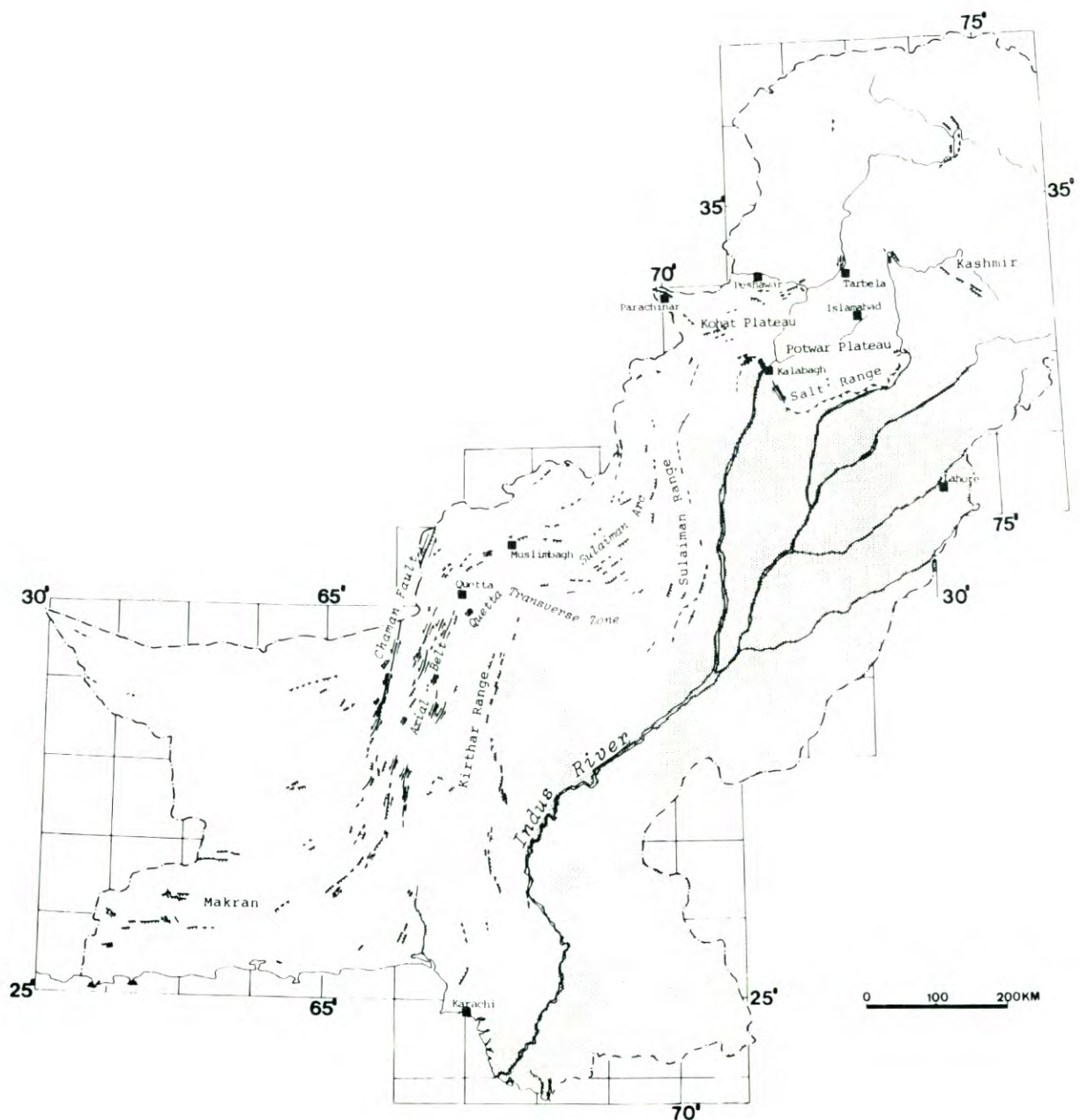


Figure 1. Summary active fault map of Pakistan providing an overview of the distribution of these features in the country. More detailed maps are given in Figures 4-8, Part I. On this and all maps the arrows indicate sense of horizontal motion on the structures, and ticks are on downthrown sides of the structures. More details on symbols are given on Figure 4, Part I.

Index to Map Sheets

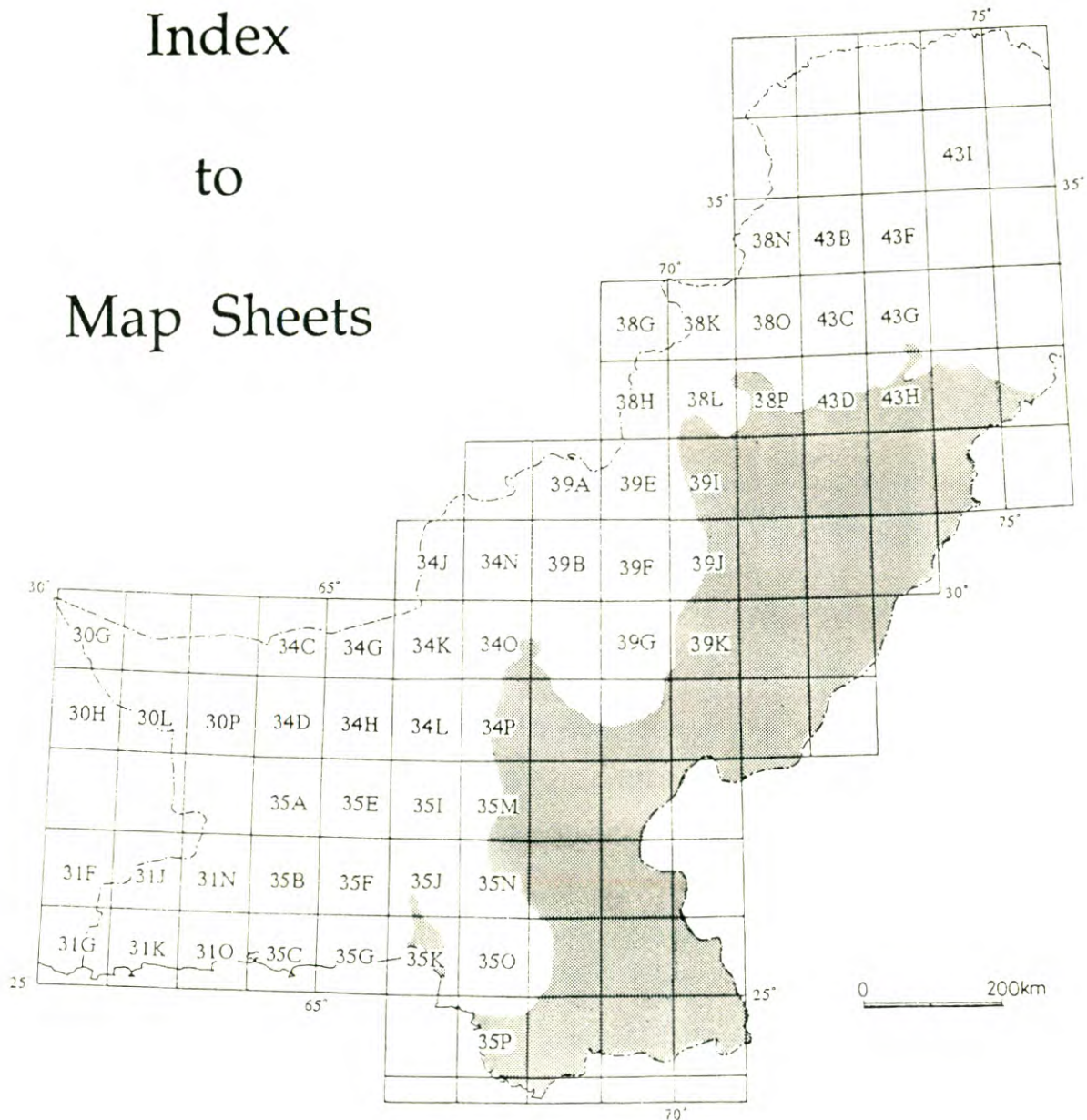
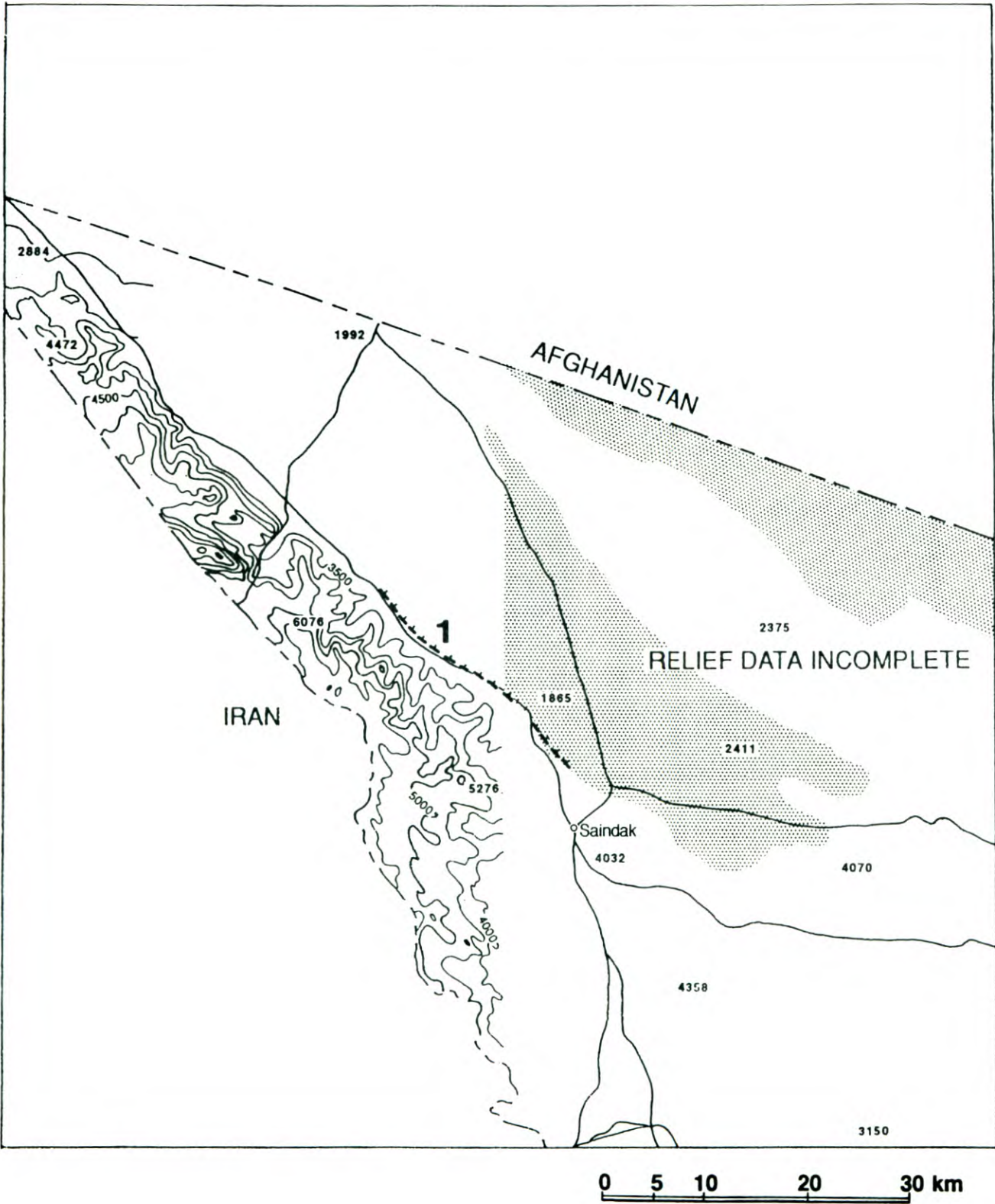


Figure 2. Location of the one degree map sheets of Part II. Only those map sheets which contain recognized active faults are given designators. These are presented in ascending order in the following pages, that is, 30G is first and 43I is last.

30G Saindak • 29-30° N by 61-62° E



The Kirtaka Fault of Kazmi and Rana (1982) is along the NE fringe of the Mir Jawa Range near the NW border with Iran. Evidence for recent motion on it is poor leading to a low certainty class (II-III). It extends for 26 km in the NW direction. The fault coincides with the boundary between the Chagai Mag-

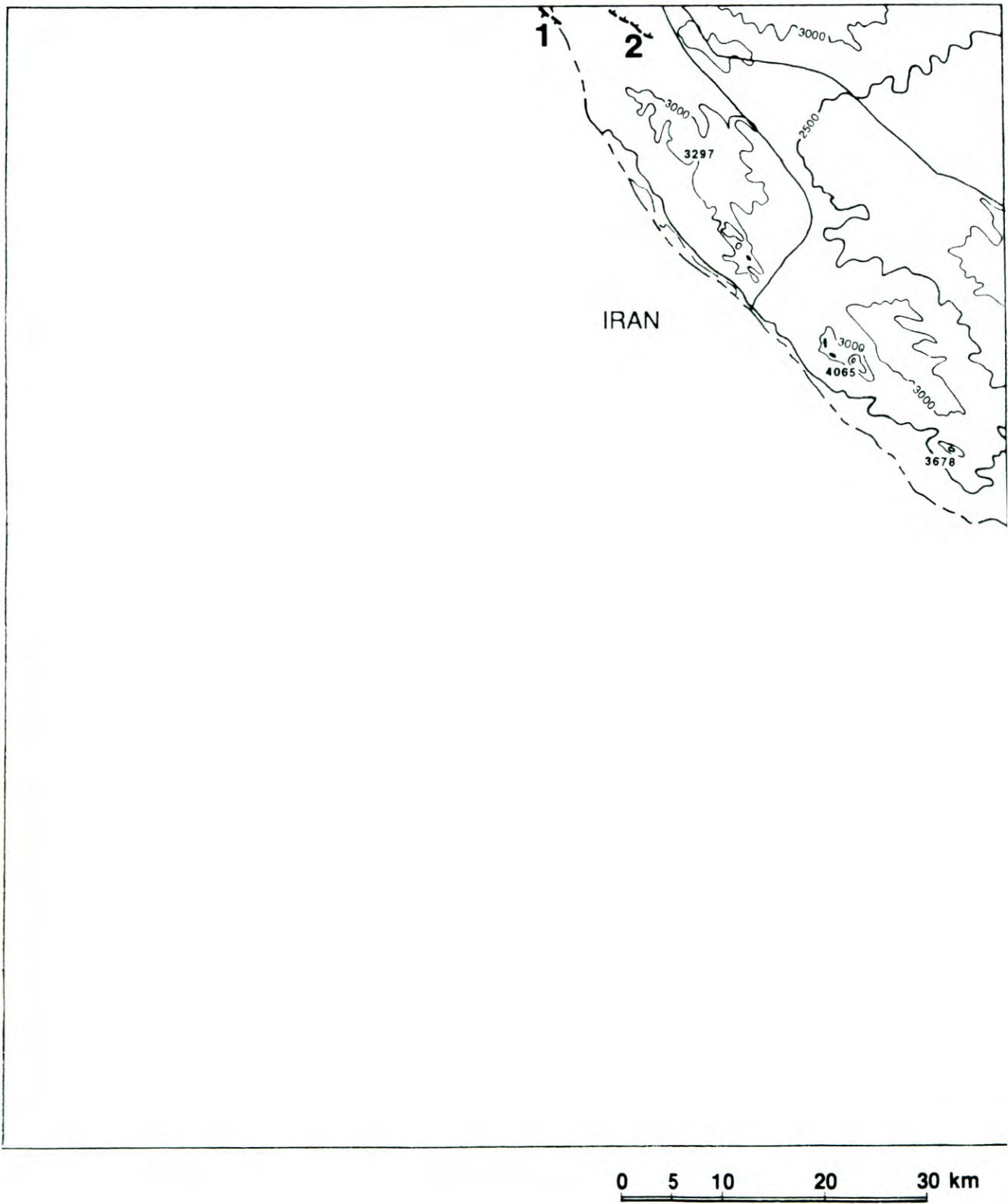
matic Arc to the north and Saindak-Dalbandin Trough to the south (Kazmi and Rana, 1982). It parallels the general strike of fold axes and reverse faults. Many obscure minor tear faults are observed as erosional lineaments oblique to the general trend of the fault.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Kirtaka	II-III		26	NW	FS	PF	SW		



Figure 1. Landsat image of the northwestern corner of Pakistan and adjacent Iran to the southeast. The mountains northwest of Saindak are bounded on the north by one fault which has a low certainty class. The mountains in adjoining Iran are the Mir Jawa Range. Landsat RBV 31440-05442-C.

30H Vasht • 28-29° N by 61-62° E

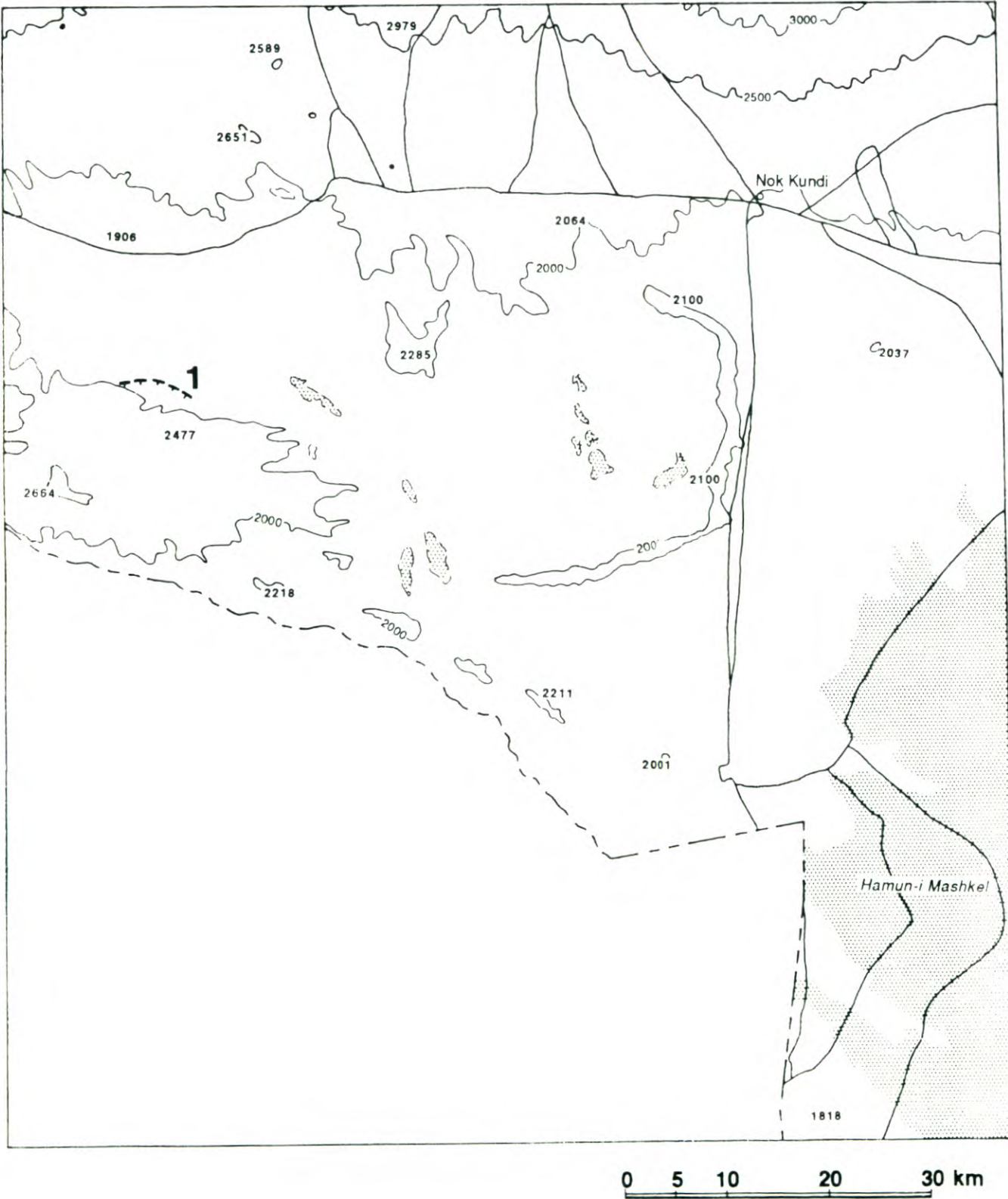


Among the folded and faulted Paleocene and Oligocene marine formations of this map-area, two short, NW-SE trending active fault traces are recognizable. The Mir Jawa Fault (1) is a class II fault that has vertically dislocated Pleistocene fan surfaces. The Lesab Fault (2)

which appears close to, but not on, the Washap Fault of Kazmi and Rana (1982), has dislocated Pleistocene fan surfaces to form a class II fault. These faults strike parallel to the regional strike of bedding and fold axes, but they have opposite senses of vertical slip.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Mir Jawa	II		2	NW	FS	PF	NE		
2	Lesab	II		5	NW	FS	PF	SW		

30L Nok Kundi • 28-29° N by 62-63° E

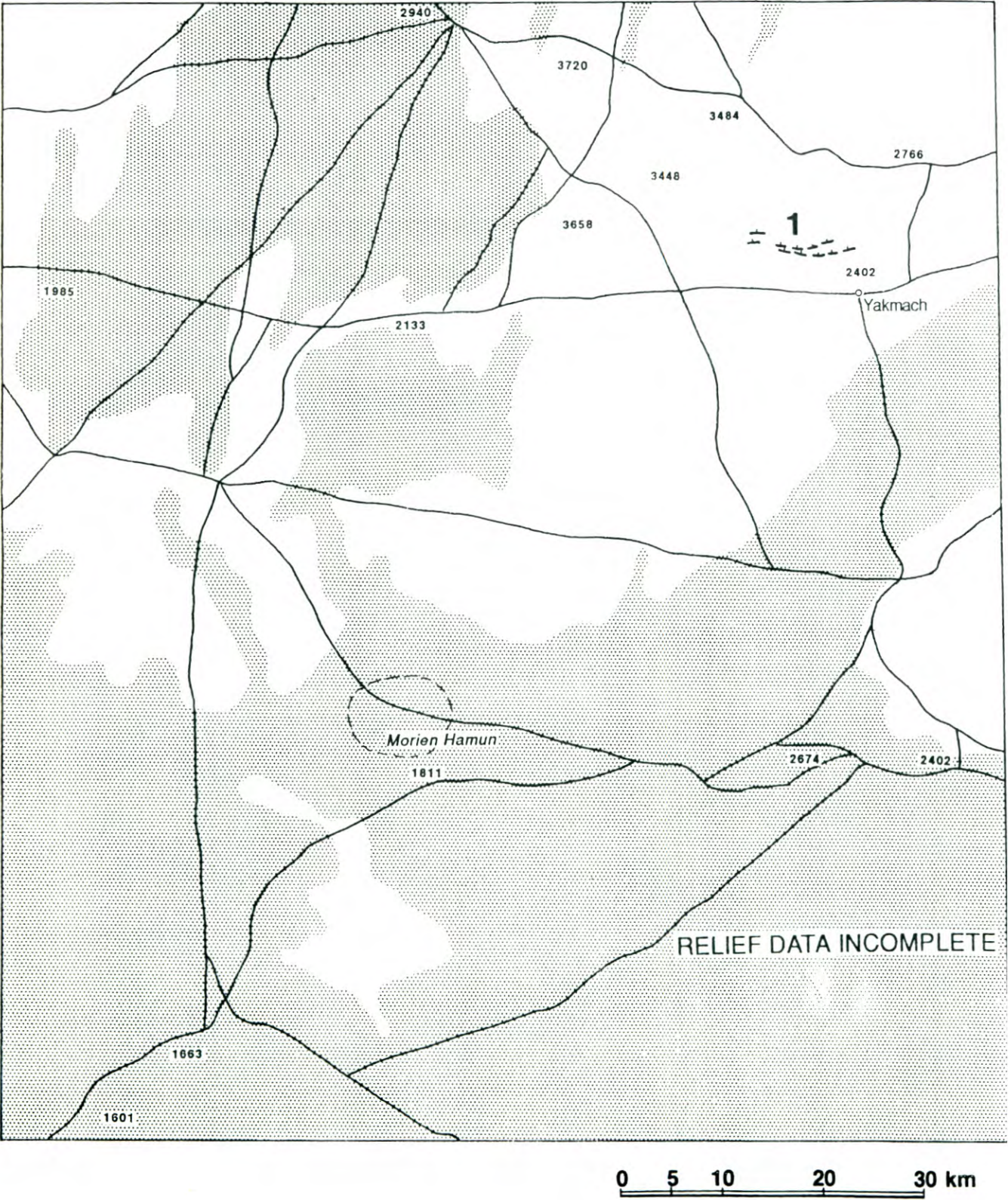


Togshi Fault (1) is the only fault suspected of being active in this map-area. It extends E-W to WNW for 7 km and dislocates Pleistocene fan surfaces by linear escarpments and reverse

scarplets. Certain portions of these scarps could be erosional in origin, and they are significantly controlled by geologic structures.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Togshi	II		7	WNW	FS,RS	PF	N		

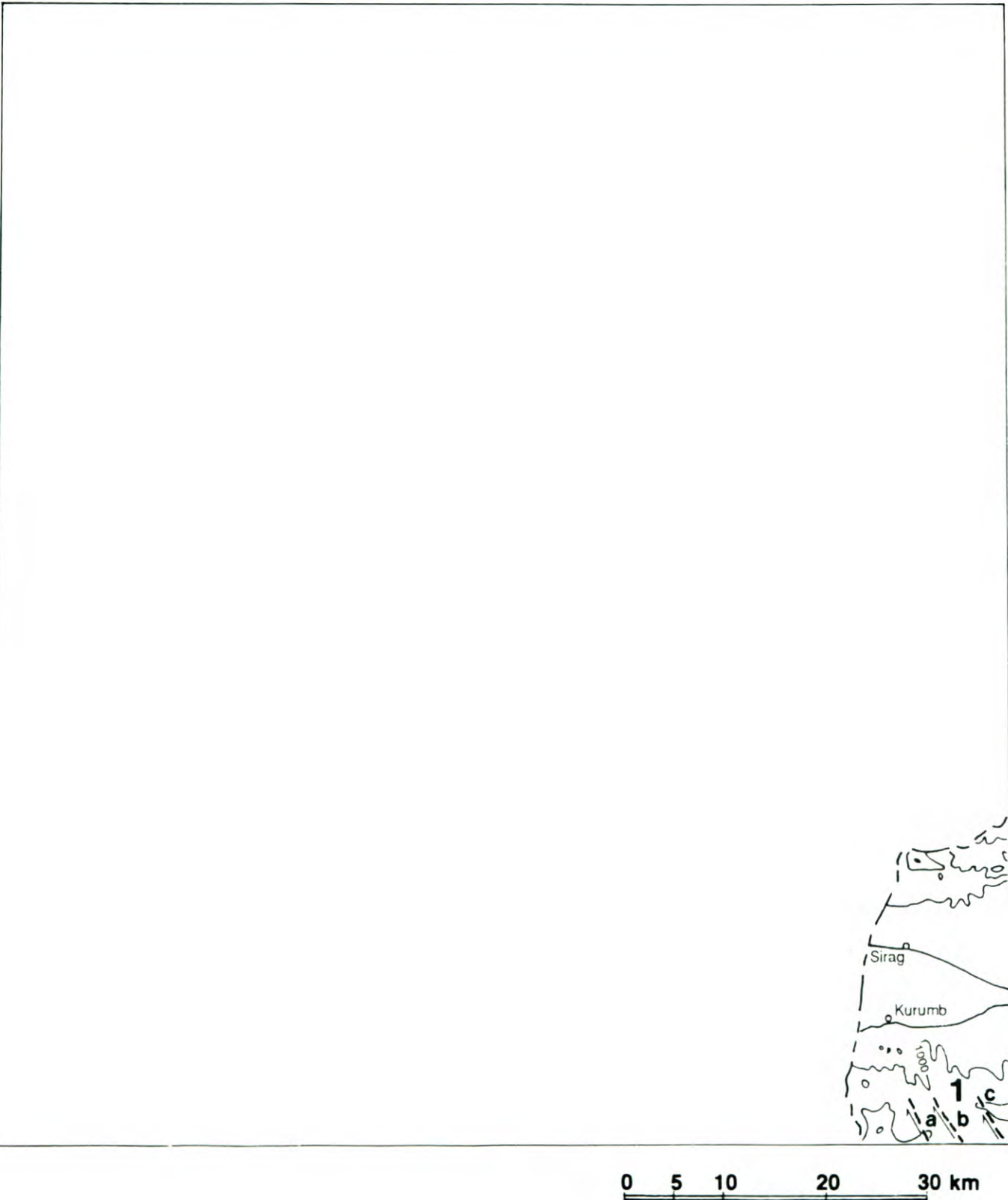
30 P Yakmach • 28-29° N by 63-64° E



In this map-area, the only possibly active fault found is the Yakmach Fault (1). E-W trending, parallel to sub-parallel scarplets off-set Pleistocene fan surfaces and extend for 11 km. However, the certainty that this fault is active is low (class II-III).

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Yakmach	II-III		11	EW	FS	PF	S		

31F Sarbaz • 26-27° N by 61-62° E



Conjugate sets of faults extending NW-SE and NE-SW form erosional linear features oblique to the general trend of bedding and fold axes in Eocene to Pliocene marine sediments throughout the Makran Flysch Basin. These are interpreted as strike-slip faults genetically related to folding. Such faults typically form late in or after the fold-forming process, and

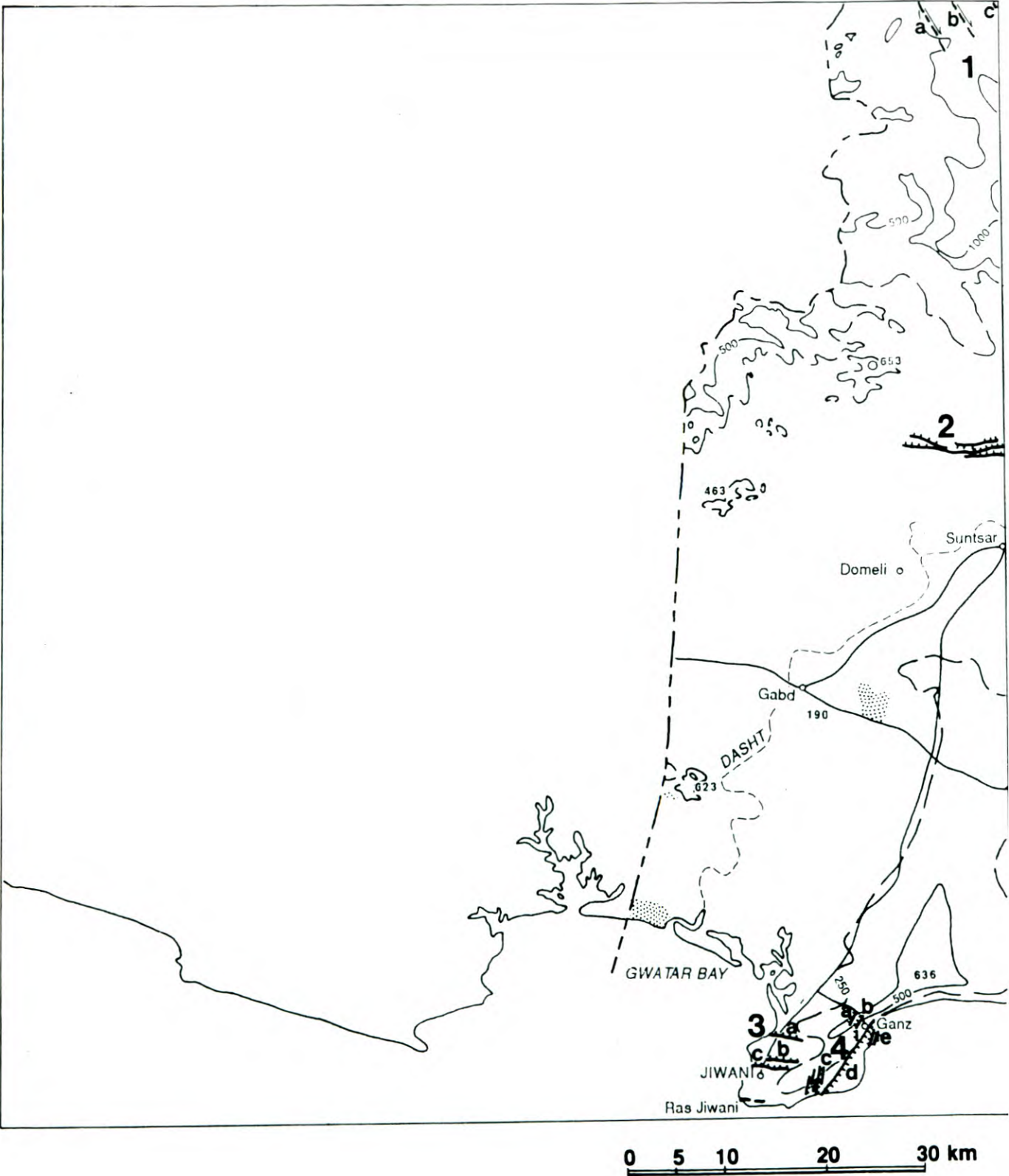
these are no exception. On this map sheet the three parallel NW-SE trending active traces of the Kurumb Fault Set are examples of such faults. These faults develop sharp linear valleys along which E-W trending geologic structures are dislocated. However, geomorphic features that indicate young displacement are not clear, and they are classified II to III.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Kurumb									
	a	II-III		(4)	NW	LV	V			31G(1a),total 10km
	b	II-III		(5)	NW	LV	V			31G(1b), total 9.5km
	c	II-III		(4.5)	NW	LV	V			31G(1c),31K(1), total 9km



Figure 1. Air photo of conjugate faults crossing bedding strike and fold axis trends from the southeastern corner of map sheet 31F. (After Figure 229C, Hunting Survey, 1960)

31G Gwatar • 25-26° N by 61-62° E



Three different types of active faults are observed in this map-area. In the northeast, the southern parts of the class II-III Kurumb Fault Set (1) extend from the NW, exhibiting one side of conjugate strike-slip faults in the north (Figure 1, Map Sheet 31F).

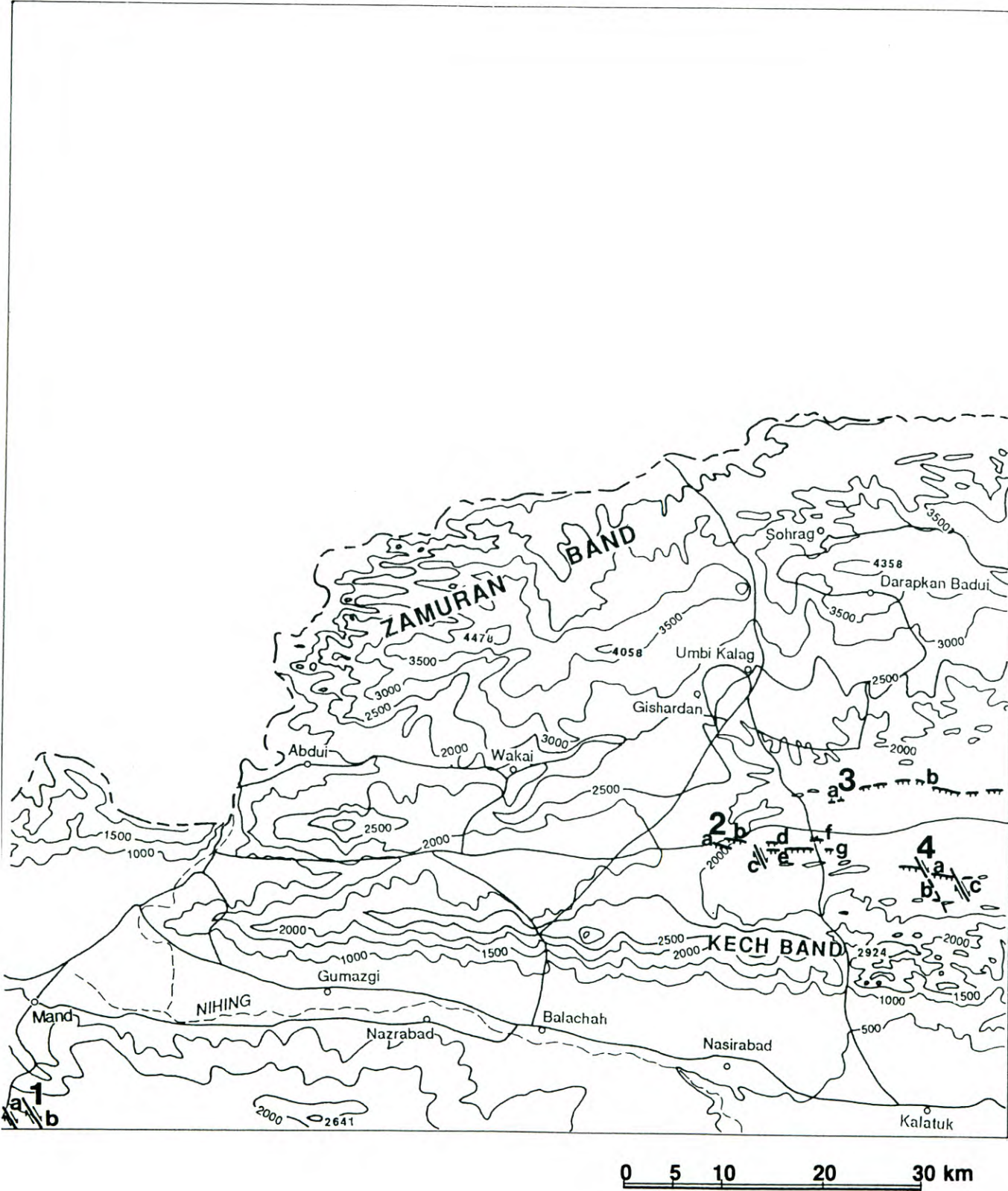
The class I Suntsar Fault (2) is located about 10 km north of Suntsar town and extends for 10 km in an E-W direction. This structure clearly dislocates older Pleistocene fan surfaces vertically along several fault traces, generally with the upthrown side to the south.

In the south, the Pleistocene marine terrace surfaces on Jiwani Peninsula are displaced

by a series of class I active faults. These faults are probably dip-slip type and are grouped into the Jiwani (3) and Ganz Faults (4) by their clustering and strikes. The Jiwani Fault is characterized by E-W striking traces and displaces the terrace surface 2-15 m vertically up to the south. On the other hand, the Ganz Fault is composed of one major trace and several sub-parallel short traces that extend NE-SW. The sense of vertical displacement along these traces is not consistent, and grabens and horsts were formed between the traces. Since there is no strike-slip component detected along the Ganz Fault, this fault could be of local extensional origin.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Kurumb									
	a	II-III		(6)	NW	LV	V			31F(1a), total 10km
	b	II-III		(4.5)	NW	LV	V			31F(1b), total 9.5km
	c	II-III		(2)	NW	LV	V			31F(1c), 31K(1), total 9km
2	Suntsar	I	C	(10)	EW	FS, Ho	PF	S(PFh: 2-15), N		Parallel traces 31K(4), total 15km
3	Jiwani									
	a	I	B	5	WNW	FS	PMT	S(10-15)		
	b	I	B	3	EW	FS	PMT	S		
	c	I	B	5	EW	FS	PMT	S(5-10)		
4	Ganz									
	a	I	B	1	NE	FS	PMT	SE		
	b	I	B	1.5	NE	FS	PMT	SE		
	c	I	B	2.5	NS	FS, Ho, Gr	PMT	W(20), E(3)		Cluster of parallel faults
	d	I	B	9	NE	FS	PMT	NW		
	e	I	B	3	NE	FS, Ho	PMT	NW, SE		Parallel traces

31J Mand • 26-27° N by 62-63° E



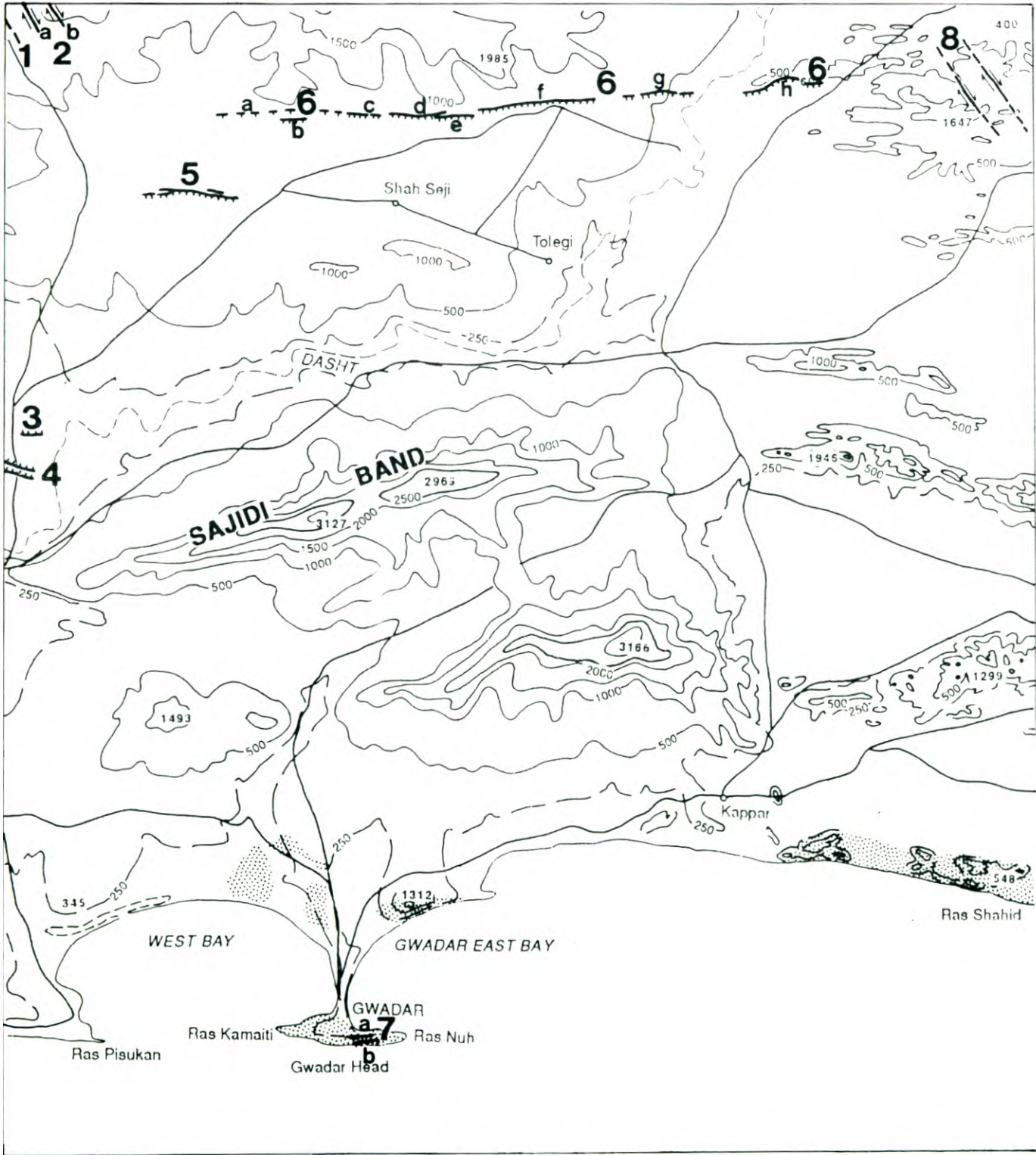
The active traces of the class I Kutal Fault Set (1) in the southwestern corner of this map-area are composed of parallel prominently strike-slip fault traces similar to those of the Kurumb Fault of sheet 31F. They extend NW-SE and offset streams right laterally by as much as 80 m.

In the peripheral zone of the basin surrounded by Zamuran Band and Kech Band, E-

W trending class I faults are densely distributed. Of these the Tapk (2), Saman (3), and Gardak (4) Faults are actively displacing a series of Pleistocene fans with dip-slip motion generally up to the north. The Sarchib Fault (4c) and some traces of the Gardak Fault trend NW-SE, and right-lateral stream offsets of as much as 100 m are observed along their traces.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Kutal									
	a	I	A	(2)	NW	LV,SO	St,V		R	31K(2a), total 5km
	b	I	A	(3.5)	NW	LV,SO	St,V		R(80)	31K(2b), total 6km
2	Tapk									
	a	I	B	2	EW	FS	PF	N(PFI: 1-2)		
	b	I	B	2	EW	FS	PF	N		
	c Sarchib	I	A	3	NW	SO	St		R(100)	
	d	I	B	1	EW	FS	PF	N		
	e	I	B	5	EW	FS	PF	N(PFm: 5)		
	f	I	B	1.5	EW	FS	PF	N,S		
	g	I	B	0.5	EW	FS	PF	N		
3	Saman									
	a	II		1	EW	FS	PF	S		
	b	I	B	15	EW	FS	PF	N(PFI:2, PFm: 15, PFh: 20)		
4	Gardak									
	a	I	B	(5)	EW	FS	PF	N(PFI: 5-15)		31N(3), total 18km
	b	I	B	6	NW	FS,SO	PF,St	NE(PFI: 3-5)	R	
	c	I	B	4	NW	FS,SO	PF,St	NE	R	

31K Gwadar • 25-26° N by 62-63° E



This map-area contains several class I active faults. In the northwestern corner of the area, right-lateral strike-slip faults (1)-(2) appear from the adjacent map sheets (31F and 31J). These are continuations of the Kurtal and Kurumb Faults. Jamgwang Fault (8) in the northeastern corner of the map-area is also a NW-SE trending class I-II strike-slip fault, and along its active trace right-lateral stream offsets of as much as 20 m are recognizable.

The Hot Chah Fault (6) is an extensive E-W striking fault system which consists of a series of fault traces separated by narrow gaps. This dip-slip fault is parallel to the prevailing strike of Eocene to Pliocene marine beds. Pleistocene fan surfaces have been displaced up to the north along these traces. This fault could

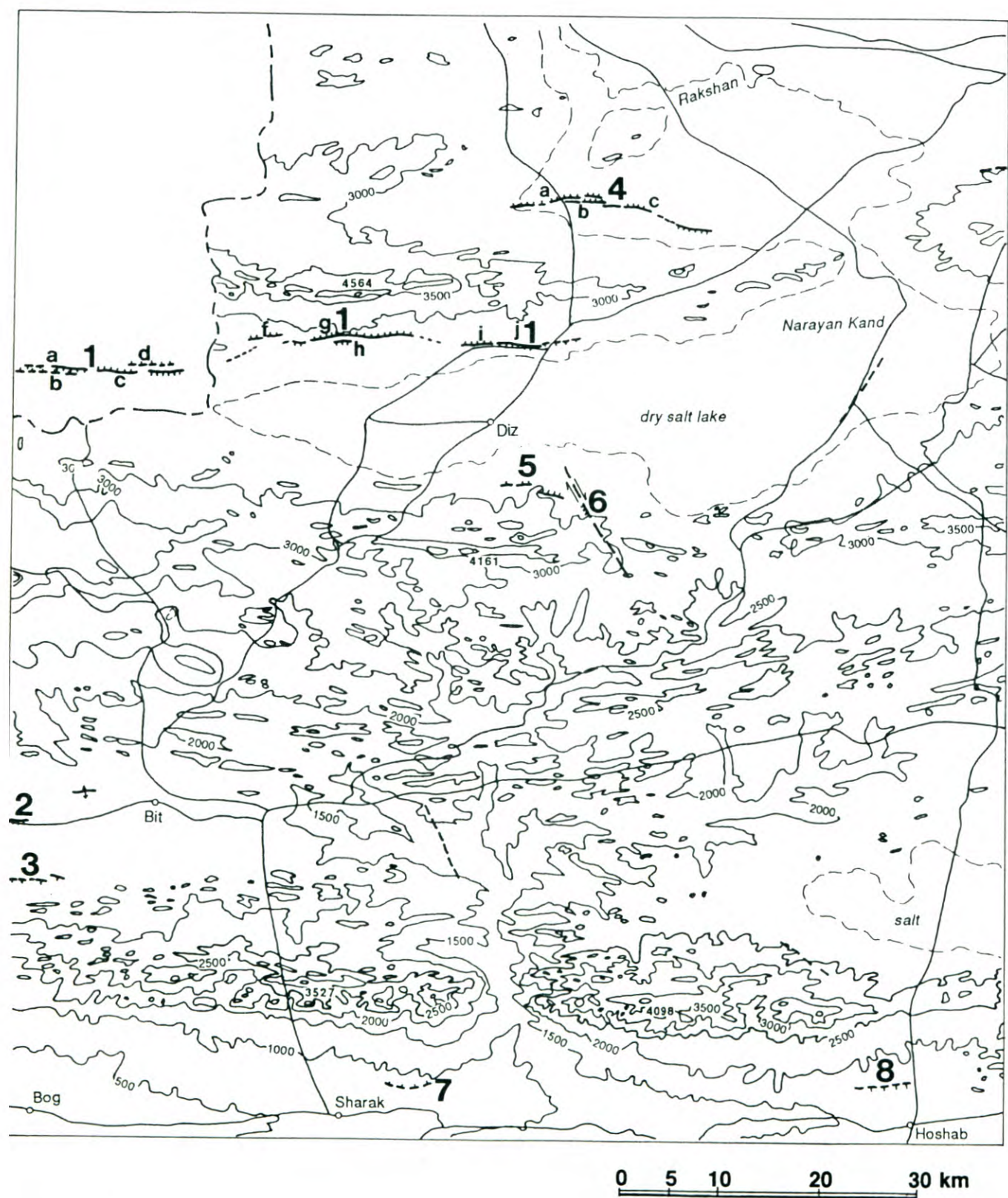
coincide with the western extension of the Panjgur Fault of Kazmi (1979b). The same type of faulting occurred along along Tulgarh Fault (5), and several levels of Pleistocene fan surfaces have been cumulatively displaced. Sa-ado Kalai Fault (3), and Suntsar Fault (4) are also dip-slip active faults which have displaced Pleistocene and Holocene fans up to the south forming distinct E-W striking fault scarplets.

In Gwadar Peninsula, the Gwadar Fault (7) has dislocated Pleistocene marine terraces vertically and formed two distinct north-facing fault scarplets running parallel to each other.

No active fault corresponding to the Western Makran Coast Fault of Kazmi (1979b) could be identified during this study.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Kurumb	II-III		(2.5)	NW	LV	V			31G(1c), 31F(1c), total 9km
2	Kutal									
	a	I	A	(3)	NW	LV,SO	St,V		R	31J(1a), total 5km
	b	I	A	(2.5)	NW	LV,SO	St,V		R(80)	31J(1b), total 6km
3	Sa-ado Kalai	I	B	2	EW	FS	HF	S		
4	Suntsar	I	C	(3)	EW	FS	PF	S(PFh: 5)		Parallel traces 31G(2), total 15km
5	Tulgarh	I	B	9	EW	FS	PF	N(PFm: 1-2, PFh: 7-12)		
6	Hot Chah			60						
	a	II		12	EW	FS	PF	N		
	b	I	B	3	EW	FS	PF	N		
	c	I	B	3	EW	FS	PF	N		
	d	I	B	5.5	EW	FS	PF	N(PFm: 5)		
	e	I	B	4	EW	FS	PF	N		
	f	I	B	11.5	EW	FS,Wa	PF	N(PFI-m: 10)		
	g	I	B	8	EW	FS	PF	N(PFI-m: 5-7)		
	h	I	B	8	EW	FS	PF	N(PFI-m: 5-7)		
7	Gwadar									
	a	I	C	2.5	EW	FS	PMT	N(5)		
	b	I	C	2.5	EW	FS	PMT	N(3)		
8	Jamgwang	I-II		9.5	NW	SO,FS	St,RB,PF	NE(PFI: 1-2)	R(20)	Parallel traces

Diz 31N • 26-27° N by 63-64° E



Extensive E-W trending dip-slip faults characterize this map-area. The Diz Valley Fault (1) consists of vertically displaced active traces of class I. They form an about 60 km long fault system along the northern fringe of an E-W synclinal basin in the Makran Flysch Basin. These active traces have dislocated Pleistocene and Holocene fan surfaces as much as 30 m vertically. The sense of vertical slip changes at places along these faults, although their trends are only deflected slightly. The Gar Fault (4) is also a dip-slip fault and its surface traces show right-stepping convex to

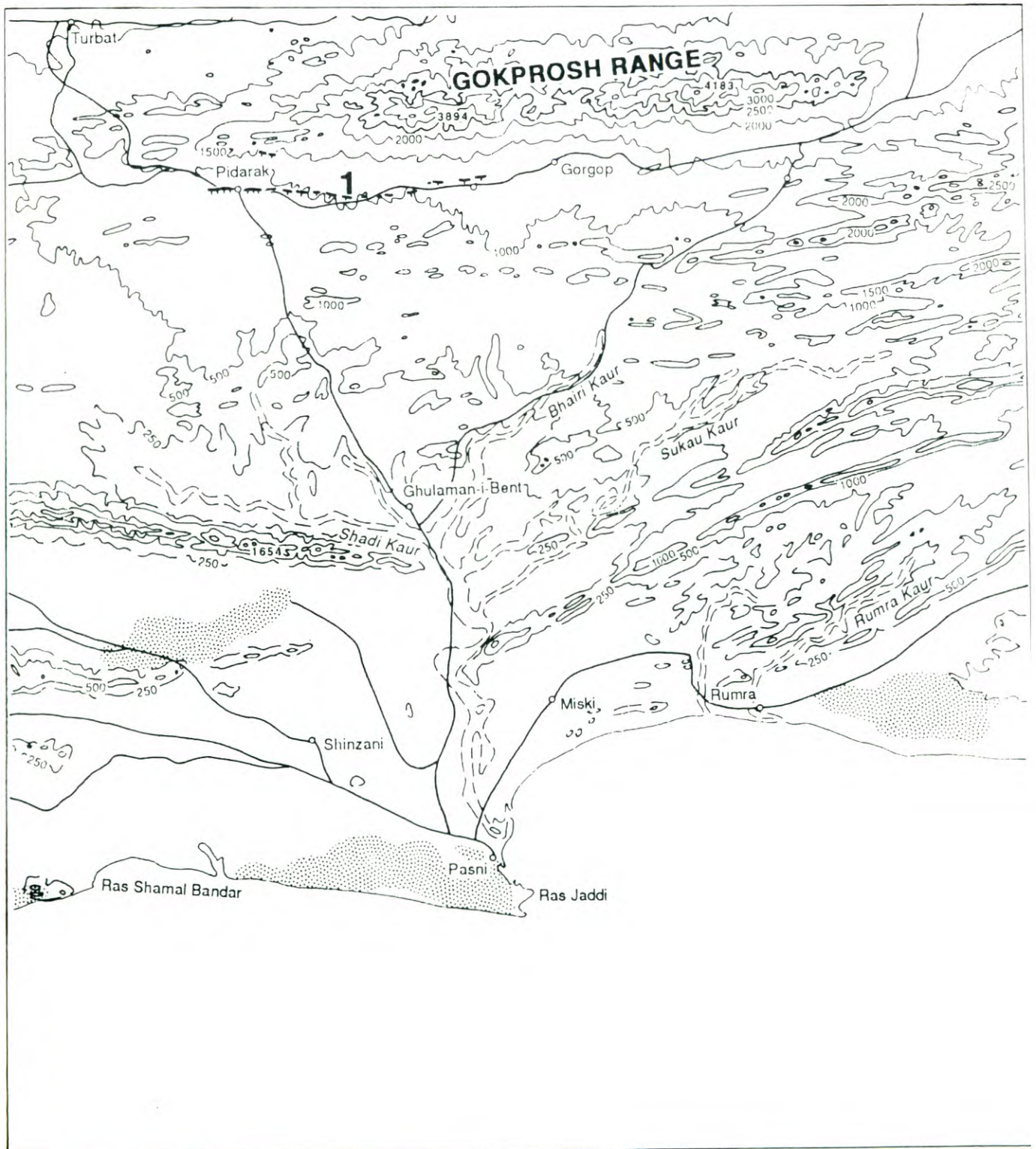
north.

Other dip-slip faults of the same character are Gish Kaur (2), Gardak (3), and Makhand West (5) Faults, but they are relatively short. East of and probably associated with the Gish Kaur Fault, an E-W anticlinal axis is still actively warping a Pleistocene fan surface.

The Makhand East Fault (6) is a NW-SE extending strike-slip fault. It coincides with one of the tear faults that intersect fold axes and cross the prevailing strike of the Turbat Group, a flysch unit, in the Central Makran Range.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Diz Valley			55						
	a	I-II	B	6	EW	FS	PF	N		
	b	II		5.5	EW	FS	PF	S		
	c	I	B	4	EW	FS	PF	S		
	e	I	B	3.5	EW	FS	PF	N(PFh: 10)		
	d	II		4	EW	FS	PF	S		
	f	I		3	EW	FS	PF	S		
	g	I		16	EW	FS	PF	S(PFm: 10, PFhh: 20-30),N		
	h	I		2	EW	FS	PF	N		
	i	I		3	EW	FS	PF	S(PFI: 5)		
	j	I-II		8	EW	FS	PF,HF	N		
2	Gish Kaur	I-II		2	EW	FS	PF	N(PFI: 2-3)		
3	Gardak	II-III		(5.5)	EW	FS	PF	N		31J(4), total 18km
4	Gar									
	a	I-II	B	9	EW	FS	PF	S(PFm: 5-10)		
	b	I	B	4	EW	FS	PF	S,N		
	c	I-II	B	11.5	WNW	FS	PF	N(PFI: 2), S		
5	Makhand West	I-II	C	6	EW	FS	PF	S(5)		
6	Makhand East	II-III		12	NW	FS, LV	V, MS	NE	R	
7	Sharak	II		5	EW	FS	PF	S		
8	Hoshab North	II		6	EW	FS	PF	N		Western extension of Hoshab F.

31O Turbat • 25-26° N by 63-64° E



0 5 10 20 30 km

Pidararak Fault (1) extends E-W for 27 km along the southern fringe of Gokprosh Range where it displaces Pleistocene fan surfaces. Escarpments are clear on the air photos. How-

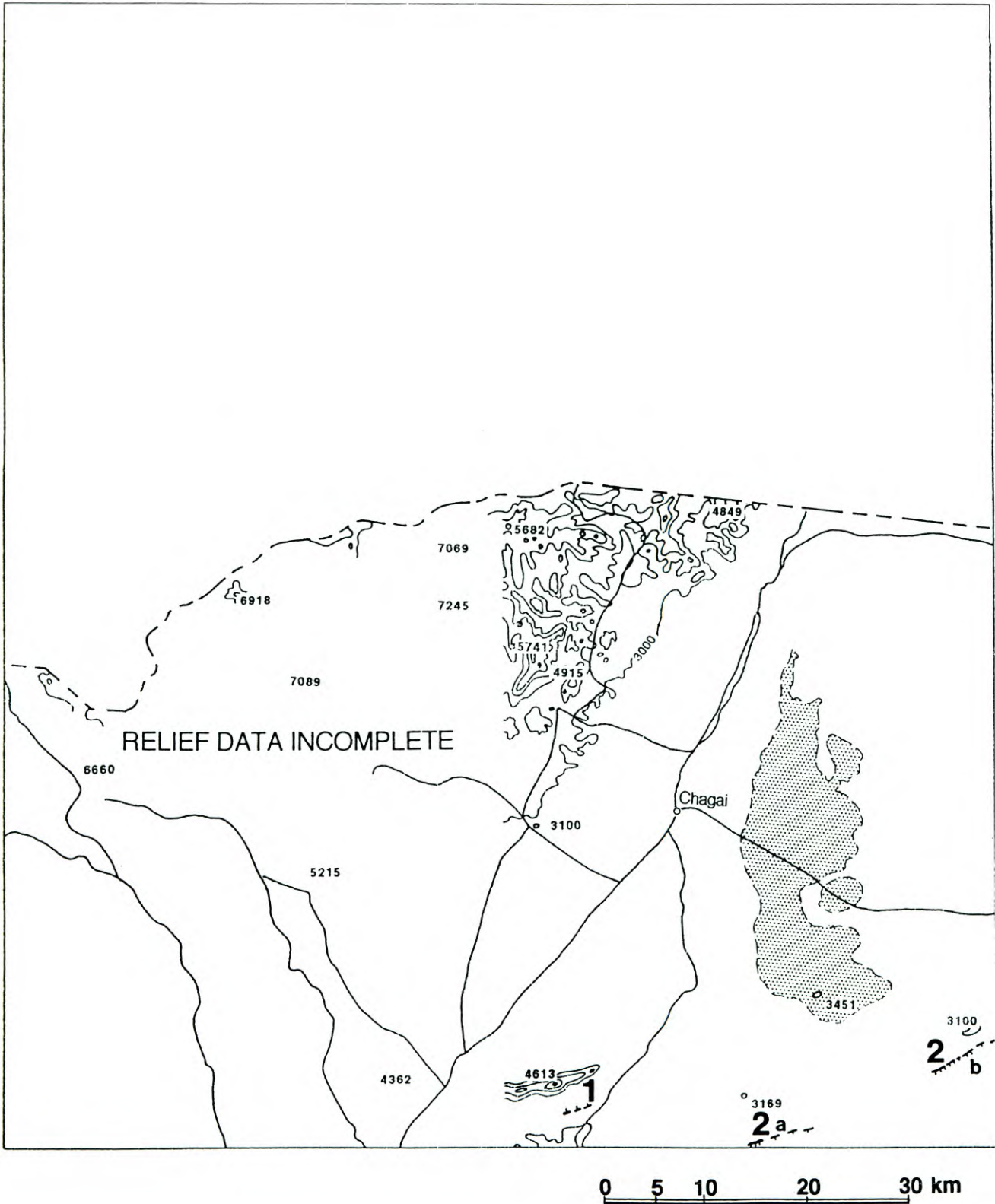
ever, it is unclear whether these features are active fault scarps or differential erosional features controlled by geological structure. Thus the Pidarak Fault is placed in class I-II.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Pidararak	I-II	C	27	EW	FS,Ti	PF	N		



Figure 1. Landsat image of area north of Pasni on the Makran Coastal Ranges. The Pidarak Fault occurs along the south side of the Gokprosh Range and can be seen as tone changes in Quaternary fan surfaces. The distance between the cross marks is 10 km. Landsat RBV 31313-05363-D.

34C Chagai • 29-30° N by 64-65° E

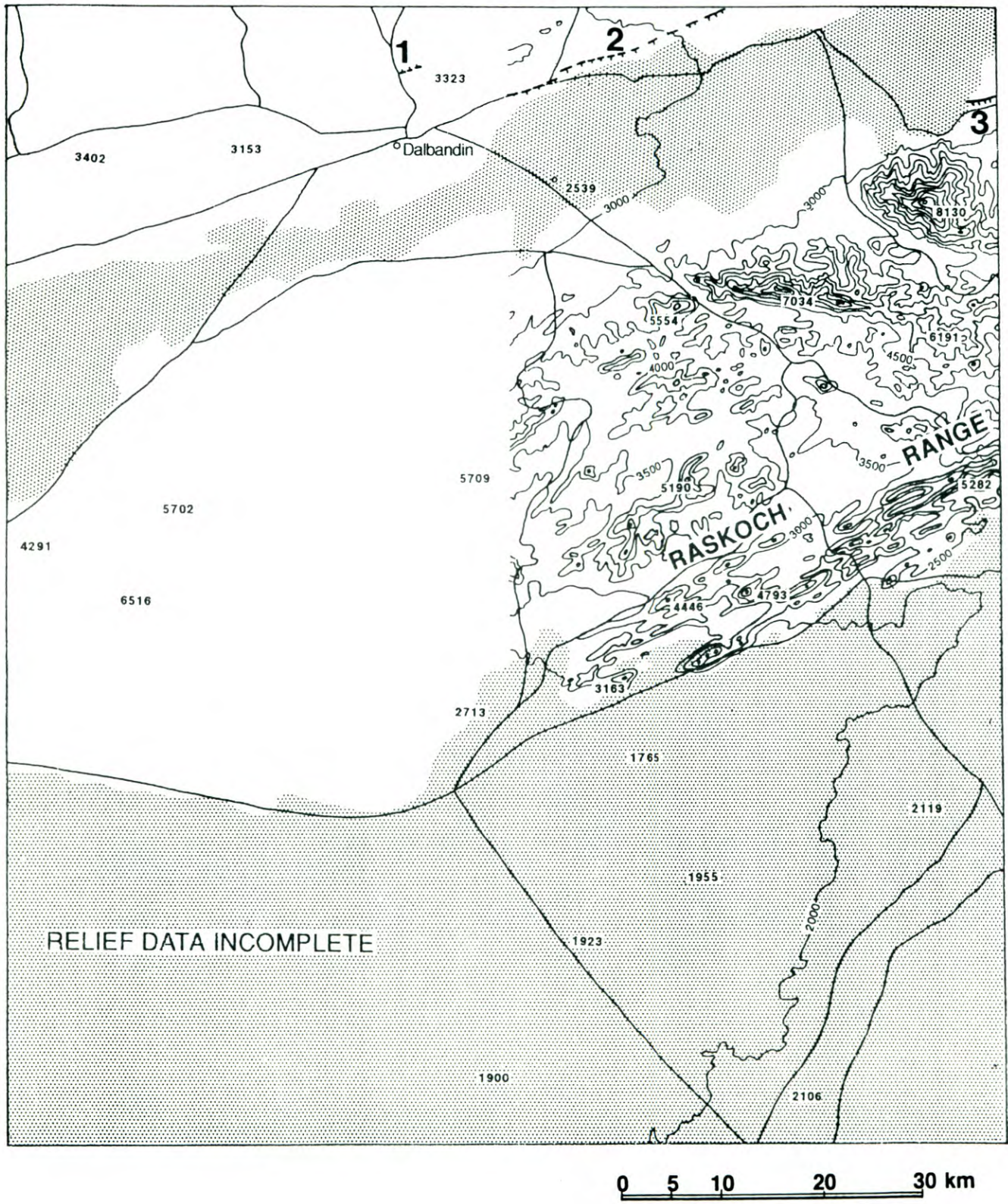


On the northern fringe of ENE-WSW extending Dalbandin Valley, Kazmi (1979b) recognized the Dalbandin Fault to which the series of active faults found by this study probably belong. Although they are on the same ENE-WSW trend, a 13 km gap separates the two segments of the Dalbandin Fault (2a and

2b). These two class I-II faults dislocate Pleistocene and Holocene fan surfaces, up to the north. The separate Chapar Fault (1) is a short dip-slip fault located slightly north of the Dalbandin Fault. Its sense of vertical displacement is down to the north.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Chapar	II	C	2.5	ENE	FS	PF	S(PFm: 5)		
2	Dalbandin			(30)						34D(2), 34G(1), total 67km
	a	I-II	C	(10)	ENE	FS	PF	N(PFm-h: 5-7)		34D(2), total 33km
	b	I-II	B	(7)	NE	FS	PF,HF	NW(HF: 1-2, PFI: 5)		34G(1), total 21km

34D Dalbandin • 28-29° N by 64-65° E



A major active feature within this map-area is the Dalbandin Fault (2) (Kazmi, 1979b). It extends ENE-WSW for 23 km in this map area and farther to the NW for a total observed length of 67 Km. It appears to dislocate a series of Pleistocene fan surfaces, but there is a chance that these features are due to differen-

tial erosion. Therefore, this fault is classed as I-II.

The Bulo (1) and Nok Chah (3) Faults are independent short active faults with dip-slip motion. The latter has dislocated a Holocene fan surface and is of higher certainty (class I).

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Bulo	II		1.5	ENE	FS	PF	S		
2	Dalbandin	I-II	C	(23)	ENE	FS	PF	N(PFm: 5-10, PFh: 10)		34C(2), 34G(1), total 67km
3	Nok Chah	I		2.5	ENE	RS	HF,PF	N		

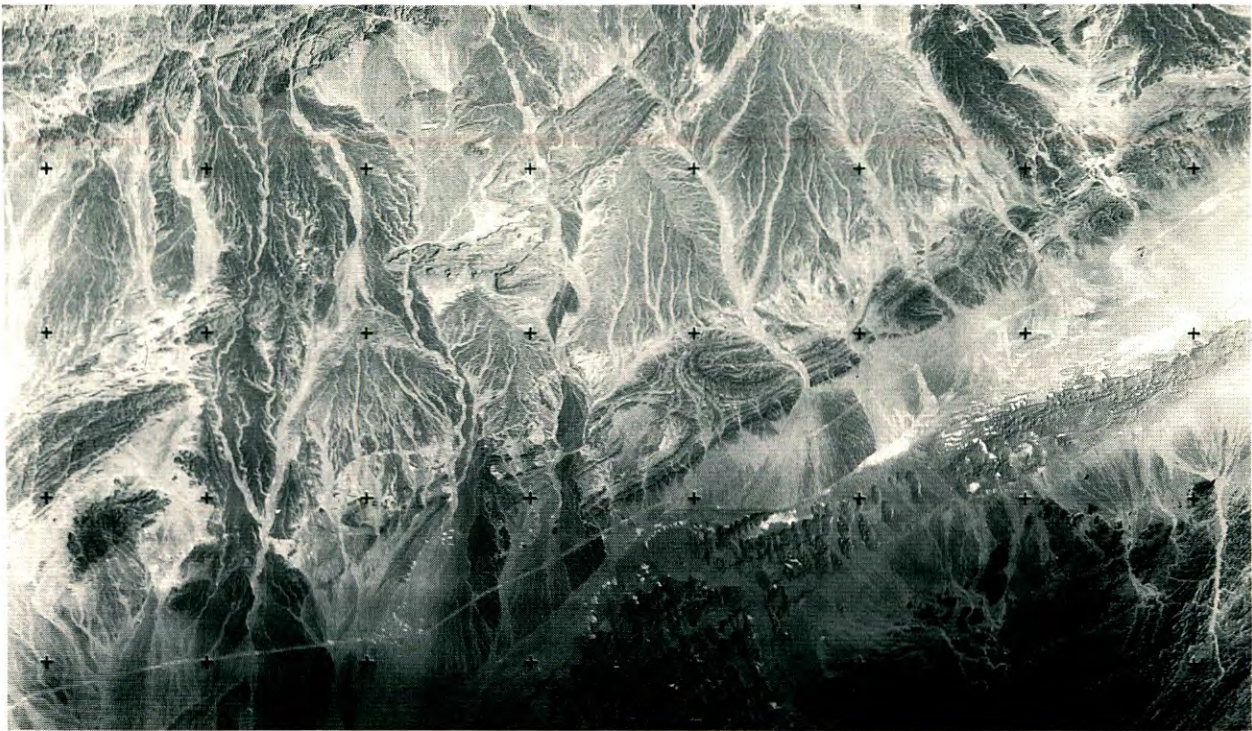


Figure 1. Landsat image of the Daslbandin Valley, southern Chagai Hills, and northern Ras Koh (Map sheets 34C and 34D). The Dalbandin Fault is northeast of Dalbandin town in the southern part of the image where folded rocks are in sharp contact with Quaternary sediments. Distance between cross marks is 10 km. Landsat RBV 31313-05354-B.



The Chaman Fault (2) appears in the southeastern part of this map-area, exhibiting a variety of tectonic feature along its active traces. The fault is a left-lateral strike-slip fault composed of parallel, en echelon active traces with gaps for step-over of inactive portions. Fresh stream offsets and fault scarplets on Holocene terraces indicate that the fault is very active and has moved repeatedly during recent geologic time.

West of the Chaman Fault, the Ahmad Wal Fault (3), previously named Jurakin Fault by Lawrence and Yeats (1979), Tafui Fault (4)

and Usman Fault (5) form a chain of active traces from ENE to SSW. The active trace of Usman Fault is a part of the fault of the same name first described by Lawrence and Yeats (1979). Left-lateral strike-slip movement is also expected along these faults, but only on Tafui Fault is such a displacement is detectable from offsets of streams.

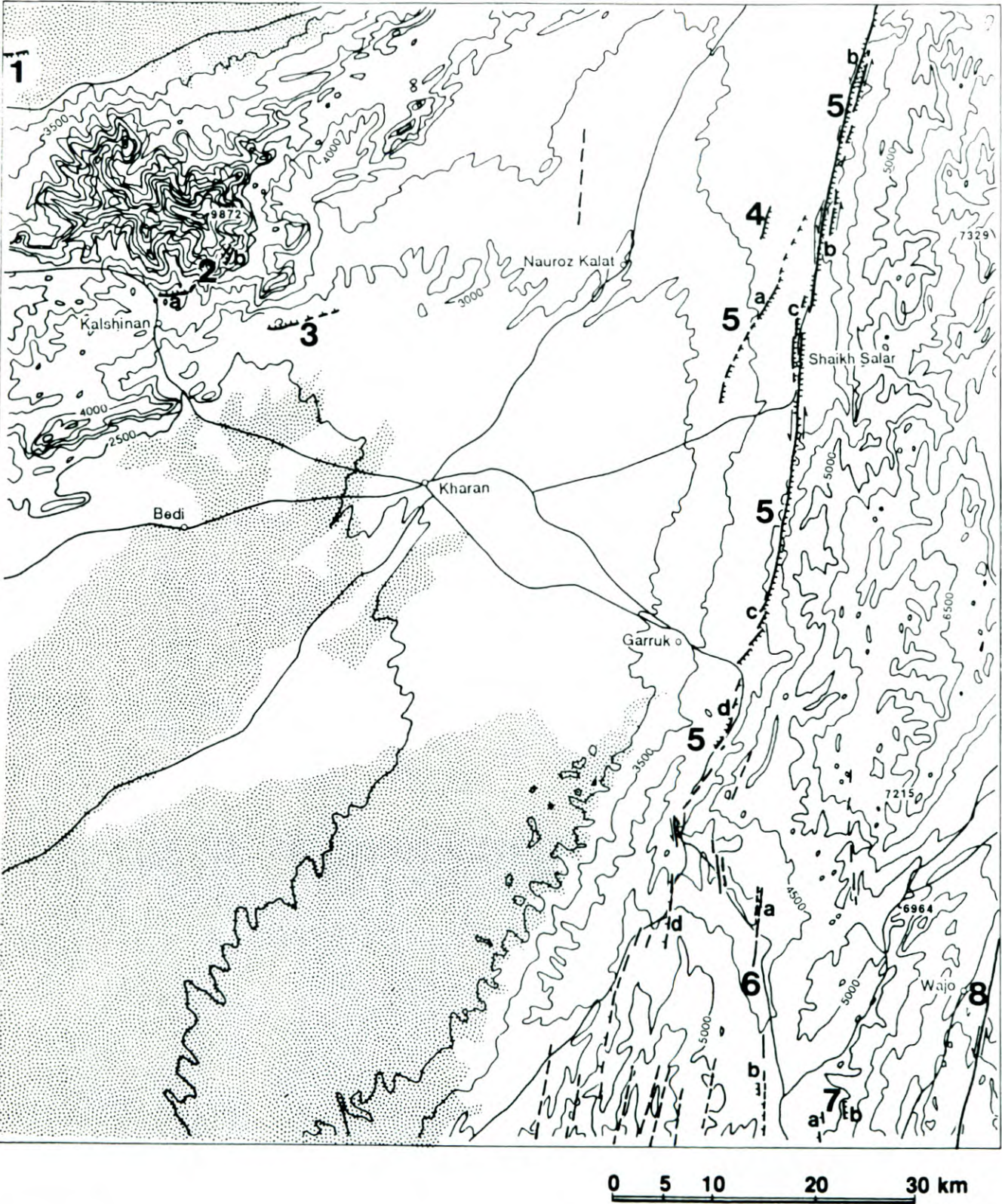
In the southwestern part of the map-area, the dip-slip Dalbandin Fault (1) has formed fault scarplets in Pleistocene fan surfaces that are up to the north.. The class of this fault is rather low (II-III).

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Dalbandin	II-III		(14)	ENE	FS	PF	N		34C(2),34D(2), total 67km
2	Chaman	I	A	(57)						34H(5), 34J(1), 34K(1)
	a	I	A	28	NNE	FS,SO,PR	HF,PF,St	E(HF:1-7, PFm: 2-10)	L	
	b	I	A	17	NNE	FS,SO	HF,St	E,W(HF: 0.5-1, PFI: 1-2, PFm: 2-30)	L(80)	
	c	I	A	18	NNE	FS,ST	HF,PF,St	W	L	
3	Ahmad Wal	II		11	NNE	FS	PF	E		
4	Tafui	I	A	7.5	NE	FS,PR,SO	HF,St	SE(PFI: 2-3, PFm: 5)	L	
5	Usman	I	A	2	NE	FS	PF	SE(PFm: 2-3)		



Figure 1. Photo of the Tafui Fault (4) showing scarp in fan gravels with left-lateral offset streams.

34H Kharan Kalat • 28-29° N by 65-66° E



In the northwestern part of this map-area, three short E-W to NE-SW trending faults (class I, I-II) have dislocated Pleistocene fan surfaces. Displacement is vertically up to the north along the Nok Chah North Fault (1) and up to the south along the Kalshinan (2) and Shand (3) Faults.

The Chaman Fault (5) is an extraordinarily distinctive tectonic feature that forms the main transform fault along the western margin of the boundary between the Indian and Eurasian Plates (Lawrence and others, 1981). This class I fault is prominent in the eastern part of the map-area. In the north, it forms one 65 km long, continuous segment trending NNE-SSW, which is associated with antithetic and/or parallel traces. The southern 30 km of

the fault consists of short en echelon traces and gaps. Fault motion recorded by Quaternary materials is always left-lateral and is west-side up in most places; it is east-side up only at three locations. In this displacement pattern, the neotectonic behavior is opposite to the long term displacement that has raised the mountains of flysch up on the east side of the fault. At Kisan near Shaikh Salar an old tomb of a local chief, said to have been built before the British invasion, remains intact close to Chaman Fault. Considering its high activity and lack of tomb damage at the time of Chaman Earthquake of 1892, this portion of the Chaman Fault possesses a high potential for generating a large destructive earthquake in the near future.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Nok Chah North	I		(2)	EW	FS	PF,HF	N(PFI: 1-2)		
2	Kalshinan	I		4	EW	FS	PF	S(PFm: 5)		
		I		2	NE	FS	PF	SE(PFh: 1)		
3	Shand	I-II	B	8	ENE	FS	PF	S(PFh: 2-3)		
4	Khukab	I		3.5	NNE	FS,SO	PF,St	W	L	
5	Chaman	I-II	A	(95)						34G(2), 34J(1), 34K(1)
	a	I	C	20	NNE	RS	PF,St	W(PFm: 1-3)	L	
	b	I	A	30	NNE	RS,SO	PF,HF,St	W(PFI: 1-5, PFh: 10-30), E	L	
	c	I	A	38	NNE	RS,SO,PR	PF,HF, St	W(PFm: 5-10), E	L	
6	Gazzi River	I	B	25						
				8	NS	FS,Sg	PF	E(PFm: 2-4), W(PFm: 0.5-1)		
		I-II		10	NS	FS,Sg	PT,PF	E(PFhh: 1-15)		
7	Gazzi East	I-II		3	NS	FS	PF	E		
		I-II	C	1.5	NS	FS	PF	W		
8	Ghazaband	I-II	A	(20)	NNE	LV,SO,PR	V,St		L	34K(11), 354L(1), 35E(14)

34H Kharan Kalat



There are some sub-parallel structures such as Khukab Fault (4) branching southwest-ward from the Chaman Fault in the north half of the map-area. In the Paleogene flysch belt in the south, the Chaman Fault seems to diffuse into many N-S trending splay faults.

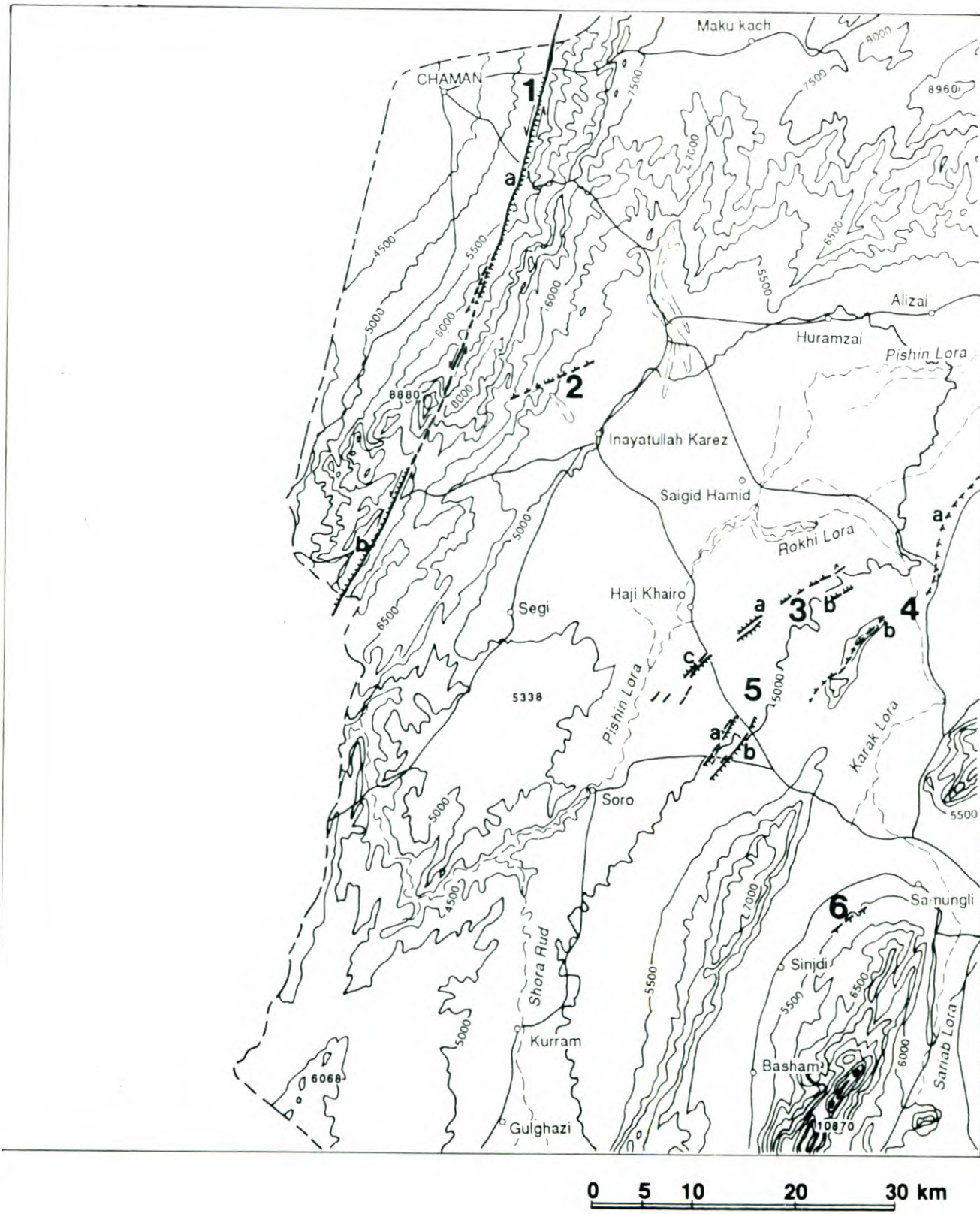
In the southwestern corner of the map-area, a portion of the southern Ghazaband Fault (8) (Kazmi, 1979b) has offset streams and ridges left laterally. Pressure ridges have formed along its trace.

Figure 1, facing page. Landsat Image of Quaternary alluvial fans displaced and left-laterally offset by the Chaman fault. Various gray tones of fans reflect different ages of desert varnish on their surfaces. One west splaying active fault can be seen near the center of the image. The cross marks are 10 km apart. Landsat RBV 30285-05263-C.



Figure 2. Air photo of the active trace of the Chaman Fault showing details of offset fans. Located near the bottom of Figure 1. Pictures is about 8 km from top to bottom (Figure 244, Hunting Survey, 1960).

34J Chaman • 30-31° N by 66-67° E



The Chaman Fault (1), which separates the Chagai/Kandahar Volcanic Arc and the Khotak Flysch Belt in this map-area, displays young tectonic features such as offset streams, linear valleys, pressure ridges and fault scarp-lets. Left-lateral strike-slip is distinctive all along the fault traces, while the small component of dip-slip changes locally from up to the east to up to the west. The Chaman Earthquake of 1892 (Intensity = 9-10) was generated by the displacement of Chaman Fault in this map-area.

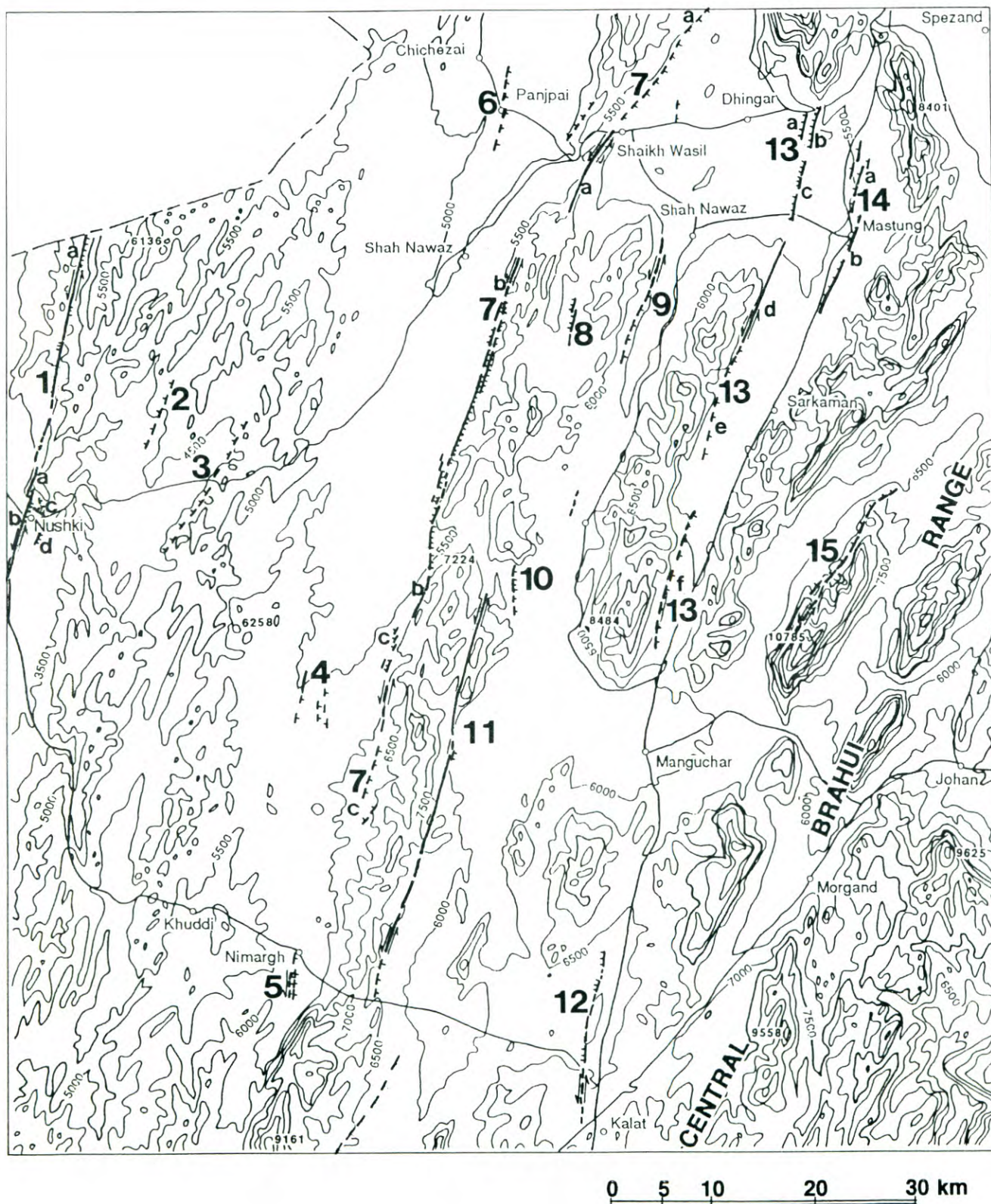
East of the Pishin Lora, Pleistocene fan surfaces formed by its tributaries are vertically

dislocated along several active traces belonging to the class I Shinkozai(3) and Dinar(5) Faults. They strike NE-SW, parallel to the axes of associated folds. The traces of the Pishin (4) and Dinar (5) Faults roughly coincide with the trace of Ghazaband Fault of Kazmi (1979b). They indicate that this major structure is probably active.

The epicenter of Quetta Earthquake of 1935 was located somewhere along the eastern edge of the Chiltan Range, southwest of Quetta. However, there are not any distinctive active faults in the area that can be related to this earthquake.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Chaman			(67)						34G(2),34H(5),34K(1)
	a	I	A	40	NNE	FS,SO, LV,PR	PF,Ri,V, HF,St	W(HF: 1-2, PFm: 10), E	L(120)	
	b	I-II	A	15	NNE	SO,FS,LV	St,PF,Ri	E	L	
2	Inayatullah Karez	I-II	C	12	ENE	FS	PF	S(PFm: 2-5, PFh: 10-15)		
3	Shinkozai			25						
	a	I-II	C	13	NE	FS,Ho	PF,HS	SE(PFh: 5-10), NW(PFh: 2-3)		
	b	I		2	NE	FS	PF	SE(PFm: 5-10)		
	c	I		5	NE	FS,Ho	PF	NW(PFh: 5), SE		
4	Pishin			(30)						
	a	II		13	NNE	FS	PF	W		34N(1), total 21km
	b	II-III	C	11	NE	FS	MS	SE		
5	Dinar			7						
	a	I	B	6	NE	FS,Ho	PF	NW(PFh: 10), SE		
	b	I	B	7	NE	FS	HF,PF	NW(PFh: 2-5, PFh: 10)		
6	Samungli	II		4	NE	FS	PF	NW		

34K Kalat • 29-30° N by 66-67° E



This map-area is characterized with many class I active faults striking NNE. The Chaman Fault (1) displays distinctive young tectonic features throughout its extent, deforming

Pleistocene and Holocene fluvial surfaces and lineaments. An isolated hill west of Nushki and an elongated pressure ridge south to it are outstanding features formed by faulting.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Chaman			(34)						34G(2), 34H(5), 34J(1)
	a	I	A	27	NNE	FS,SO,Gr	MF,PF,HF, St	W(HF-PFL: 1, PFm-h: 12),E	L	
	b	I	A	10	NNE	FS,PR	HF,PF,St	E(HF: 2,PF1:5), W(PFh: 20)	L	
	c	I	B	2	WN	FS	PF	S(5)		
	d	I	B	2	W	FS	PF	W(PF1: 3)		
2	Kishingi West	II-III		8	NNE	FS	PF	E		
3	Kishingi East	II-III		15	NE	FS	PF	SE		
4	Patki	II		3	NS	FS	PF	W		
5	Nimargh	II		5	NS	FS,SO	PF,St	W(PFhh: 5-15)	L	
6	Panjpai	II-III		8	NNE	FS	PF,HF	W		
7	Bhalla Dhor			85						
	a	I-II	B	25	NE	SO,FS	St,PF	NW	L(40)	
	b	I	B	37	NNE	RS,Ho,SO	PF,HF,St	W(PFh: 30), E	L	
	c	II-III		20	NS	SO,FS, RS	St, PF	W,E(PF: 15-20)	L	
8	Shoro	I		4.5	NS	FS	PF	E(3-5), W		
9	Johak	II		12	NNE	FS,SO	MS,St	W	L	
10	Ghulam Jan	I-II		4.5	NS	FS,Ho	PF,HF	W(1-10), E		
11	Ghazaband	I	B	40	NNE	SO,LV,FS	St,V,PF	W(PFm: 5), E(PF1:2)	L(800)	34H(8), 34L(1), 35E(14)
12	Kalat	I - II	B	26	NS	FS,SO,PR	PF,St	E(PF1: 2-5, PFm: 10), W	L	
13	Mastung West		B	55						
	a	I		2.5	NNE	FS	HF,PF	E(PF1: 5)		
	b	I		4	NNE	FS	HF,PF	E(PF1: 10)		
	c	I		5.5	NNE	FS	HF,PF	E(PF1: 1-2)		
	d	I	B	14.5	NNE	FS,SO,SR	MS,St	W	L(100)	
	e	II		6	NNE	FS	HF,MS	W		
	f	II-III		13	NNE	FS	MS	W		Cluster of traces
14	Mastung East			20						
	a	II		7	NNE	FS	PF	E(PFm: 15-20)		
	b	I	B	10	NNE	FS,Wa	PF	E(10-15)		
15	Koh-I-Maran	II		17	NE	FS,SO	PF,St	E	L	

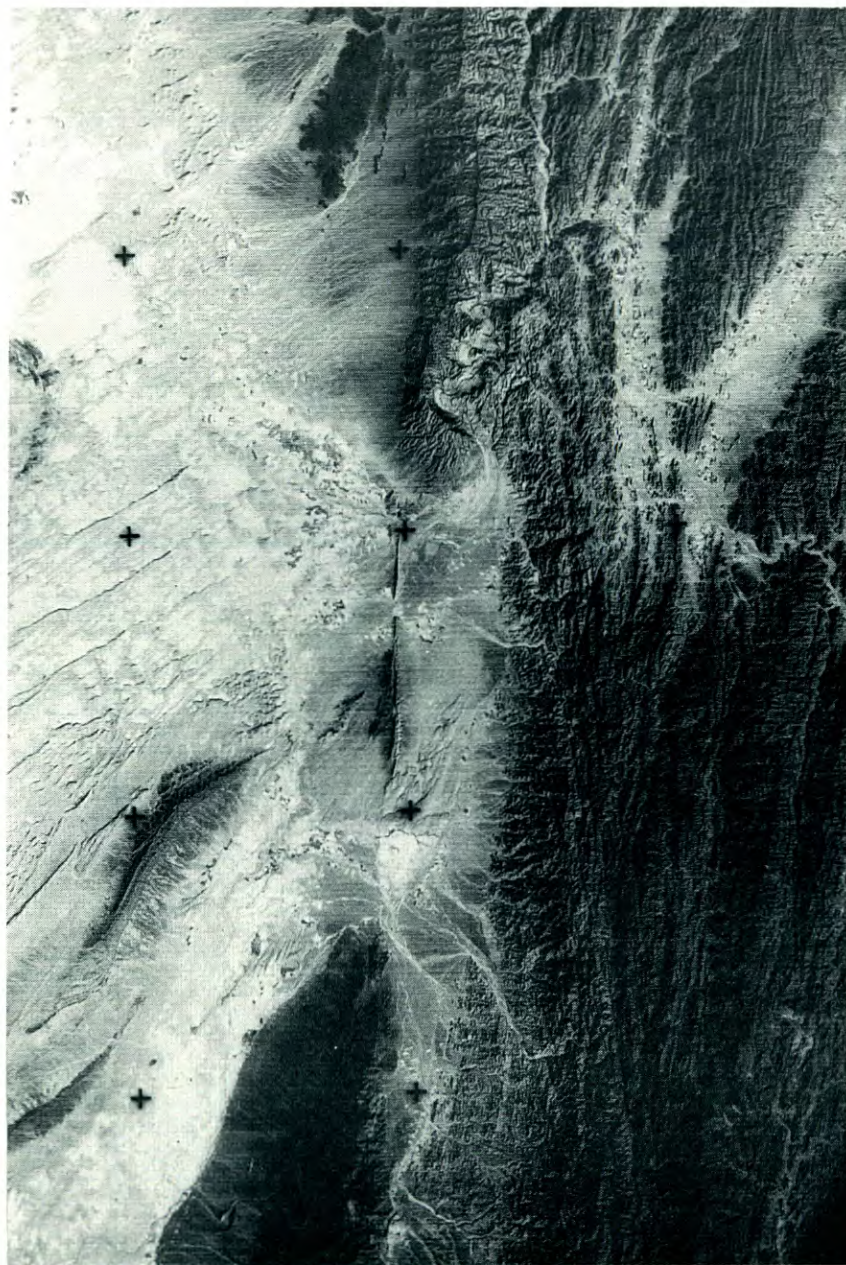


Figure 1. Landsat image of the Chaman Fault with prominent pressure ridges at Nushki. Nushki town is just north of the north end of the cross at the north end of the isolated pressure ridges. The distance between the crosses is about 10 km. Landsat RBV 30285-05263-A.

Many offset streams indicate recent left-lateral movement on this fault. No displacement was reported on the Chaman Fault in this map area at the time of the Chaman Earthquake of 1892. Though smaller earthquakes have taken place in recent years, this segment still remains as a candidate for a major earthquake in the near future.

In Khojak Flysch Belt, many active faults of higher certainty run NNE-SSW parallel to general trend of geological structures. The Bhalla Dhor Fault (7) first mapped by Hunting Survey (1960), is an 85 km long left-lateral strike-slip fault and is composed of right-stepping segments. In the central part of the fault,

Pleistocene and Holocene fan surfaces were displaced vertically by parallel-running traces and grabens and horsts were formed between the traces. The Ghazaband Fault (11) is most active in this map-area and a left-lateral stream offset of as much as 800 m is observed along the trace. The Mastung West Fault (13) is also a fault of same character and displays tectonic features formed by both lateral and vertical displacements. Many other faults extending in the same direction in this map-area are presumably of same kind, but left-lateral offsets were not clearly observed along the traces except one on the Kalat Fault (12).



Figure 2. View looking south along the Chaman Fault from the top of the pressure ridge at Nushki. These ridges are formed of Quaternary sands and gravels squeezed up along the active fault zone. At the east edge of the ridge beside the small village of Faqir Kili these young gravels dip 70° east.



The northern half of this map-area has many N-S to NNE-SSW trending active faults. Intermittent active traces of the Ghazaband Fault (1) lie along the fault of the same name previously recognized by Kazmi (1979b). They appear along the boundary between the flysch zone to the west and the ophiolitic belt to the east. Mamatawa Fault (9) exhibits young tec-

tonic features that may be related to a large earthquake probably within historical time. These faults display clear topographical evidence for left-lateral displacement. In the southern half of the map area, several N-S trending short class I active faults are sparsely distributed.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Ghazaband		B	(60)						34H(8), 34K(11), 35E(14)
	a	I-III			NNE	FS	PF	E(2-3)		
	b	II		4	NNE	FS	PF	W(PFh: 2-3)		
	c	II		7	NNE	SO	St		L(80)	
2	d	I		3	NNE	FS	PF,MS	E(1-2)		
2	Rais	I-II		6	NE	FS	PF	SE, NW(7-10)		
3	Soruk			6						
	a	II-III		2	NNE	FS	PF	E		
	b	I	B	5	NE	FS	PF	NW(PFm: 3-5)		
4	Rodinjo	I-II		3	NNE	FS	PF	W(1-2)		
5	Anari	I	B	0.5	ENE	FS	PF	S(5)		
6	Harun	II-III		2	NE	FS	PF,RT	SW		
7	Anjira	I-II	B	8	NS	FS	PF,MS	W(10-12)		
8	Siahpad	I-II		(5)	NS	FS	PF	W(PFI: 2-3)		35I(1)
9	Mamatawa		B							
	a	II		2	NS	FS	PF	W		
	b	I-II		12.5	NS	SO,LV	St,V		L(50)	
	c	I		6	NS	PR,TC	MS,HF,PF			
	d	I		4.5	NS	FS,SO,PR	PF,St,MS	E(10), W(7-10)	L	
10	Koshkak	I-II		1	NS	FS	PF	E(PFm: 3, PFI: 1)		
11	Pandran	I	B	25	NE	FS,SO,Li	PF,St,MS	NW(5-7)	L(100)	
12	Gazan	I	B	2	NE	FS	PF	NW(1-2)		
13	Thalgan	I	B	2.5	NNE	FS	PF,HF	W(PFh: 10-15, PFI: 2-5)		

34N Quetta • 30-31° N by 67-68° E

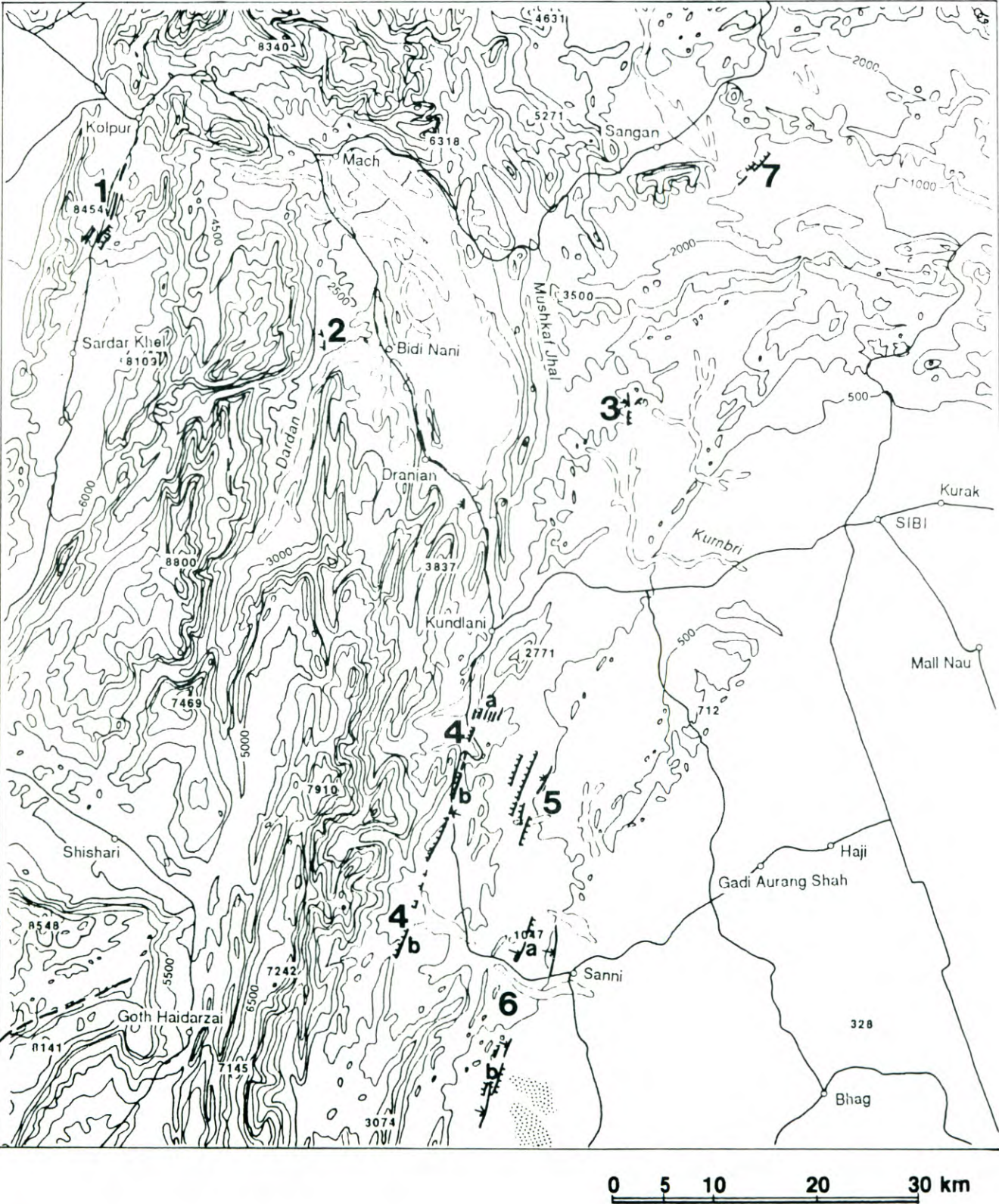


Active faults in this map-area mainly appear along the southern margin of the flysch zone. The sole exception is Pishin Fault (1) which lies on the eastern fringe of a NE-SW elongated hill made of lower Pleistocene Bostan Formation. These faults are located along the Quetta Line (Gansser, 1966) in the zone connecting the Ghazaband and Zhob Faults (Kazmi, 1979b). In the east, following the general trend of fold axes and bedding strikes, the faults tend to deflect toward east-

west. They show predominantly dip-slip motion, commonly uplifted to the north. Strike-slip offset features are detectable with low certainty only along Churmian Fault (4), which may be crossed by left-laterally displaced streams. Along the northern margin of Zhob Valley, a series of active faults discontinuously appears. The active traces north and east of Muslimbagh that displace Pleistocene fan surfaces vertically are parts of it.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Pishin	I-II	B	(8)	NE	FS	PF,HF	NW(PFh: 30-40, HF: 1-2)		34J(4), total 21km
2	Khanai	I-II		2.5	ENE	FS	PF	N(PFI: 3-10)		
3	Gwal	I-II		5						
		a		4.5	NE	FS	PF	NW(PFh: 10)		
	b	I-II	B	3.5	NE	FS	PF,HF	NW(PFm: 5-10)		
4	Churmian	II-III		15	ENE	FS,SO	MS,St	N(PFI: 2)	L(60)	
5	Balozai	I-II		3	ENE	FS	PF,HF	N		
6	Zhob	I	B	5						
		a		2	EW	FS	PF	N(PFm-h: 20)		
	b	I-II		3	EW	FS	PF	N		
7	Muslimbagh	I-II	B	8	ENE	FS	PF,MS	N(PFh: 30, PFI2-3)		

34O Sibi • 29-30° N by 67-68° E

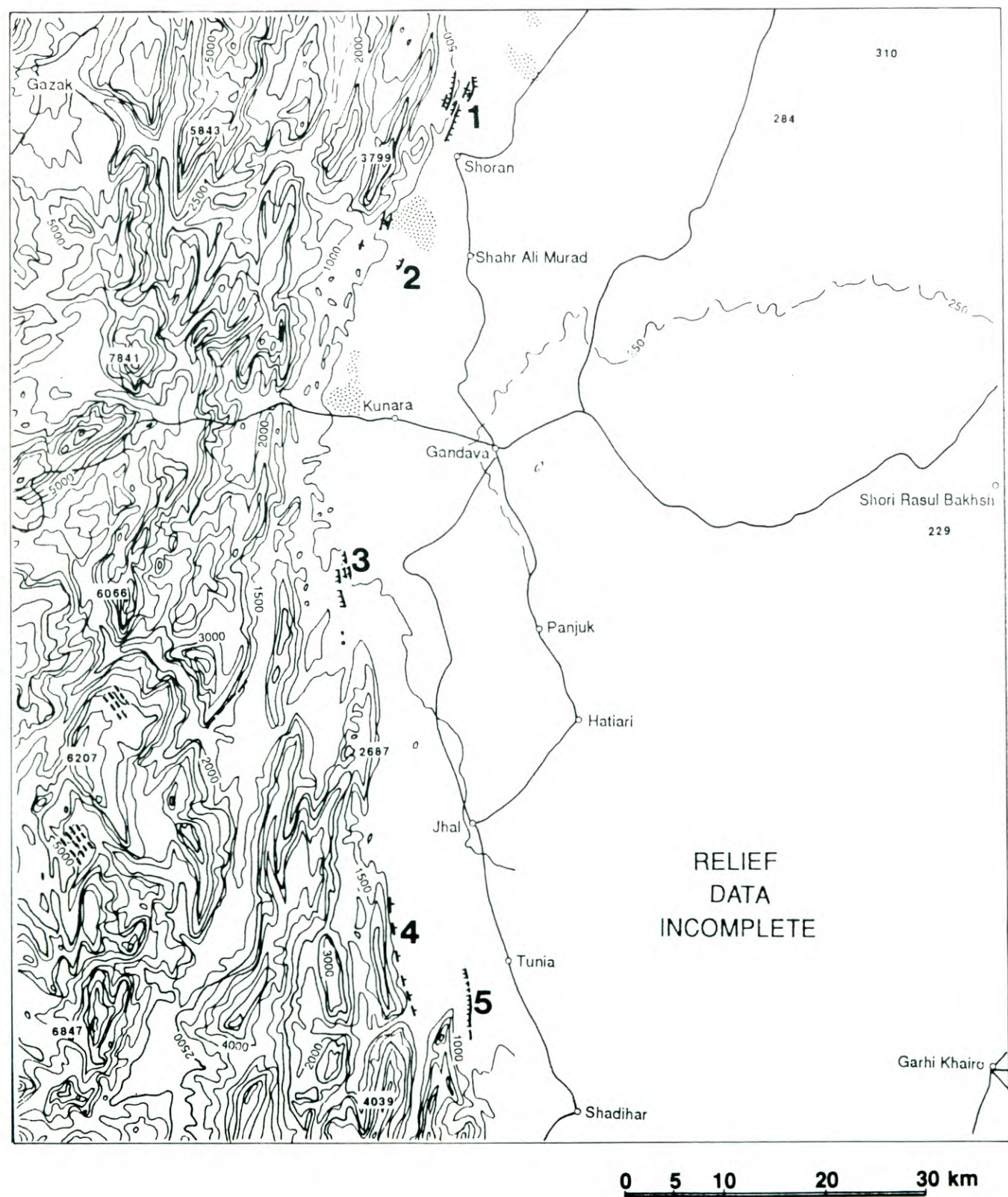


In the northwestern corner of this map-area, the Kolpur Fault (1) is a N-S striking structure that cuts the axes of folds in the Chiltan Limestone. Along the fault, stream offsets and fault scarplets across Pleistocene fan surfaces document both dip-slip and left-lateral strike-slip displacements. Many longitudinal faults (3-6), which generally parallel the NNE-SSW trending axes of folds in the Brahui Ranges, prominently dislocate Pleistocene to Holocene fan surfaces. We infer that they are

progressively younger eastward as the ones in the east cut the younger geomorphic surfaces, which are coupled with active folding along the eastern margin of the Brahui Ranges. Many of them are minor faults caused by bedding-plane slip that accompanies active folding. Tilting and warping of young alluvial fans are also characteristic along the Brahui Range Front. A typical example of this type of deformation occurs on the Pleistocene fan surface on the right bank of Tangna Pusht Jhat.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Kolpur	I-II	B	9	NNE	FS,SO	St,PF,MS	W(PFm: 5), E	L	Righ-stepping echelon
2	Bibi Nani	II-III		1.5	NNW	FS	PF	E		
3	Osepur	I	B	5	NS	FS,Ti	PF	W		Three short traces
4	Kundlani			27						
	a	I	B	2	NNE	FS,Ti	PF,HF	E(PFh: 30, PFm: 2-10), W		Parallel bedding faults
	b	I	B	20	NNE	FS,Ti	PF	E		
5	Sibsi	I	B	11	NNE	RS,Ti,Gr, Ho	PF,HF	E(PFm; 2-10), W		Parallel bedding faults
6	Sanni			20						
	a	I-II		6	NNE	FS,Ti	PF,MS	W		Warping on active folding
	b	I	C	10	NNE	FS,Ti,Ho	PF	W(PFh: 15), E		Parallel fault traces
7	Sangan	I	B	1	NE	FS	PF	SE		

34P Gandava • 28-29° N by 67-68° E



Class I active faults appear in a number of places along the eastern front of Brahui Ranges. They are NNE-SSW to N-S trending, parallel to the axes of folds, and are mostly bedding faults associated with active flexural-slip folding. Many previous workers have suggested from the strike of the faults that left-lateral displacement is taking place along the Kirthar,

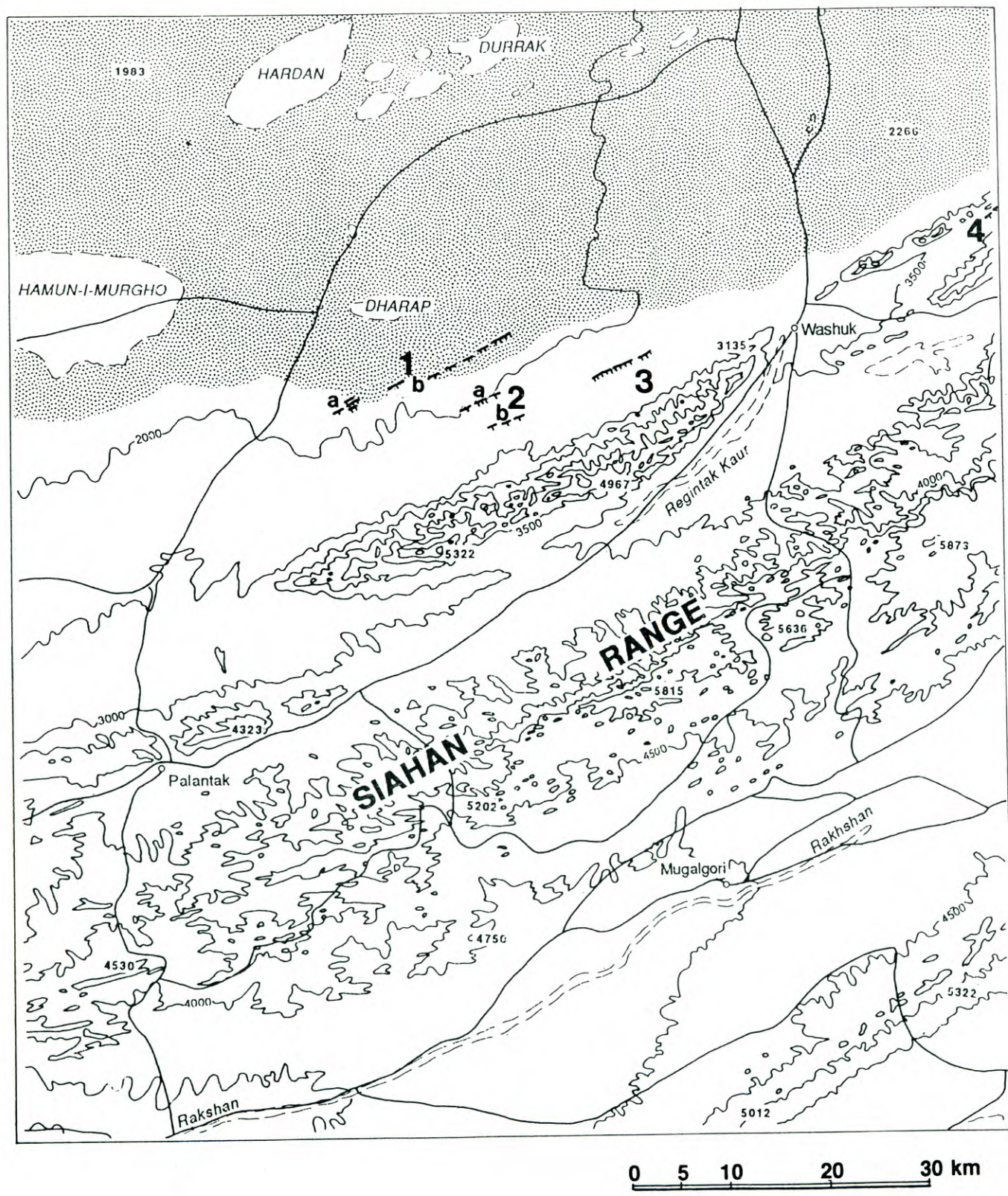
Brahui and Sulaiman Range Fronts, but only dip-slip surface faulting has been detected during this study. Along the active faults in this map-area, fault scarplets and surface warping reflecting vertical displacements are common tectonic features. No features that confirm strike-slip were found along them.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Shoran	I	B	8	NNE	FS,Wa	PF	W(PFm: 30), E		Parallel bedding faults
3	Bangal	I		1	NNE	FS	PT	E		
4	Kotra	I		6	NNW	FS	PF	E(PFm: 10, PFh: 20)		Cluster of bedding faults
5	Dhori	II		12	NNW	FS	PF,MS	W		
6	Tunia	I	B	7.5	NS	FS,Wa	PF	E		



Figure 1. Landsat image of the northeastern edge the Quetta Syntaxis at the margin between the deformed rocks of the Brahui Ranges and the undeformed sediments of the Indus Basin. The northern part shows the Sanni Fault of Map sheet 34O; the southern part shows the Shoran Fault of Map sheet 34P. Landsat MSS 2693-0573-7.

35A Washuk • 27-28° N by 64-65° E



This map-area contains few active faults. Broadly, the boundary between the Makran Flysch Belt to the south and Chagai Volcanic Arc to the north is marked by ENE-WSW aligned outcrops of Eocene to Oligocene marine sediments. Extensive Pleistocene fan deposits, sand dunes, and playa lake sediments of the Kharan Desert cover it in the northern part of this area. Along the boundary between

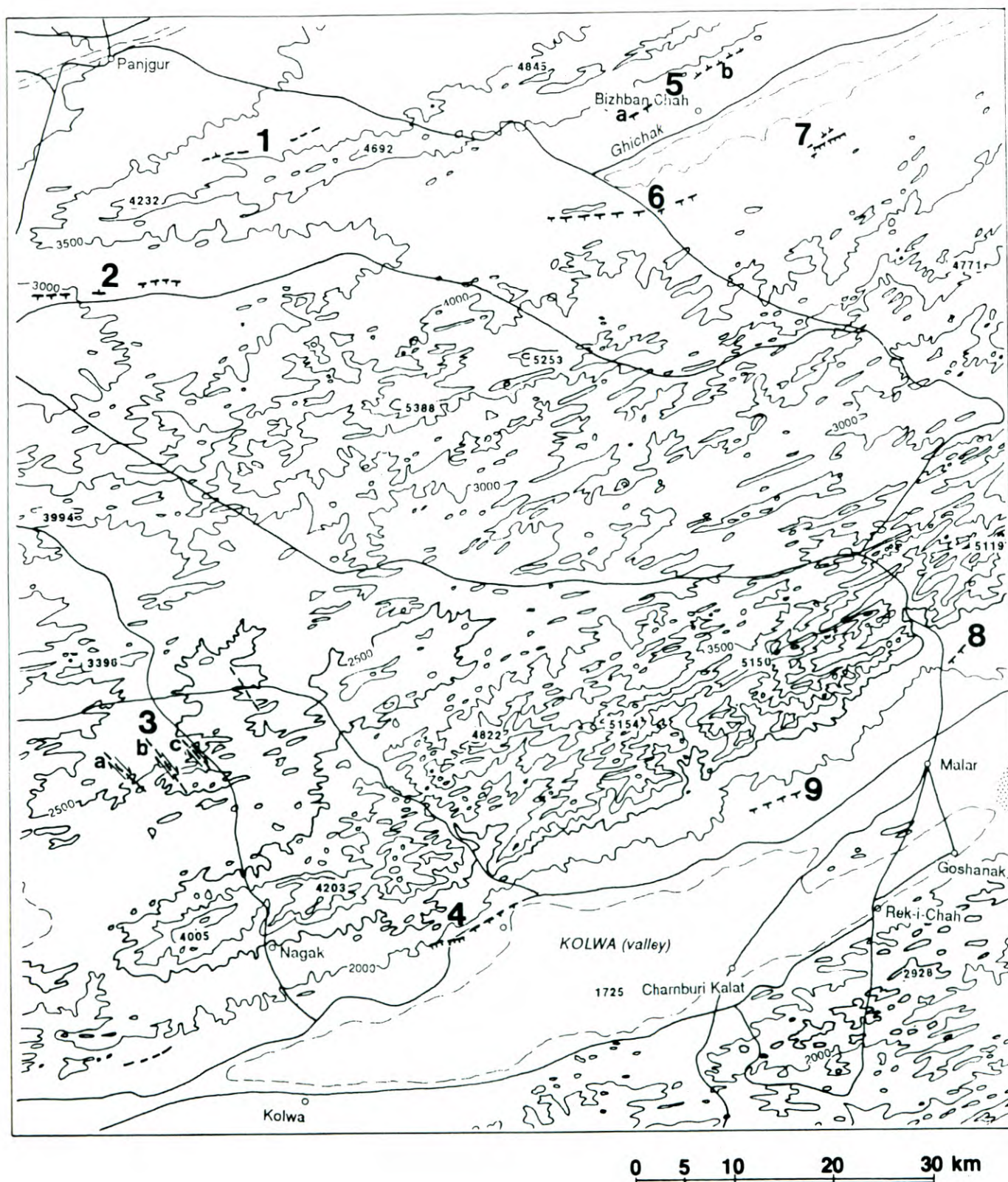
the Kharan Desert and the Makran Flysch Belt, the Dharap Fault (1) cuts the Pleistocene fan surface, forming up to NW reverse scarplets. The Ror (2) and Kherugshki (3) Faults are also dip-slip faults that dislocate the Pleistocene fan surface along the straight mountain front WSW of Washuk. Rather short parallel traces compose these active faults. Along them, only vertical displacement is recognizable.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Dharap			20						
	a	I	B	5	NE	FS	PF	NW(PFm:10)		Cluster of parallel traces
	b	I-II	B	15	NE	FS	PF	NW(PFl:3)		
2	Ror									
	a	I-II		4	NE	FS	PF	NW(PFh:10-15)		
	b	II		3.5	ENE	FS	PF	N		
3	Khergushki	I		6.5	NE	FS	PF	NW(PFl:2-3)		
4	Greshag	II	C	(2)	NE	FS	PF	N		35E(1),total 4km



Figure 1. Landsat image of the Siahan Range in the northern Makran Region. The Dharap, Ror, and Khergushki Faults are located along the northern margin of the mountains where scarps in young sediments are present. Landsat MSS 2659-05205-7.

35B Panjgur • 26-27° N by 64-65° E

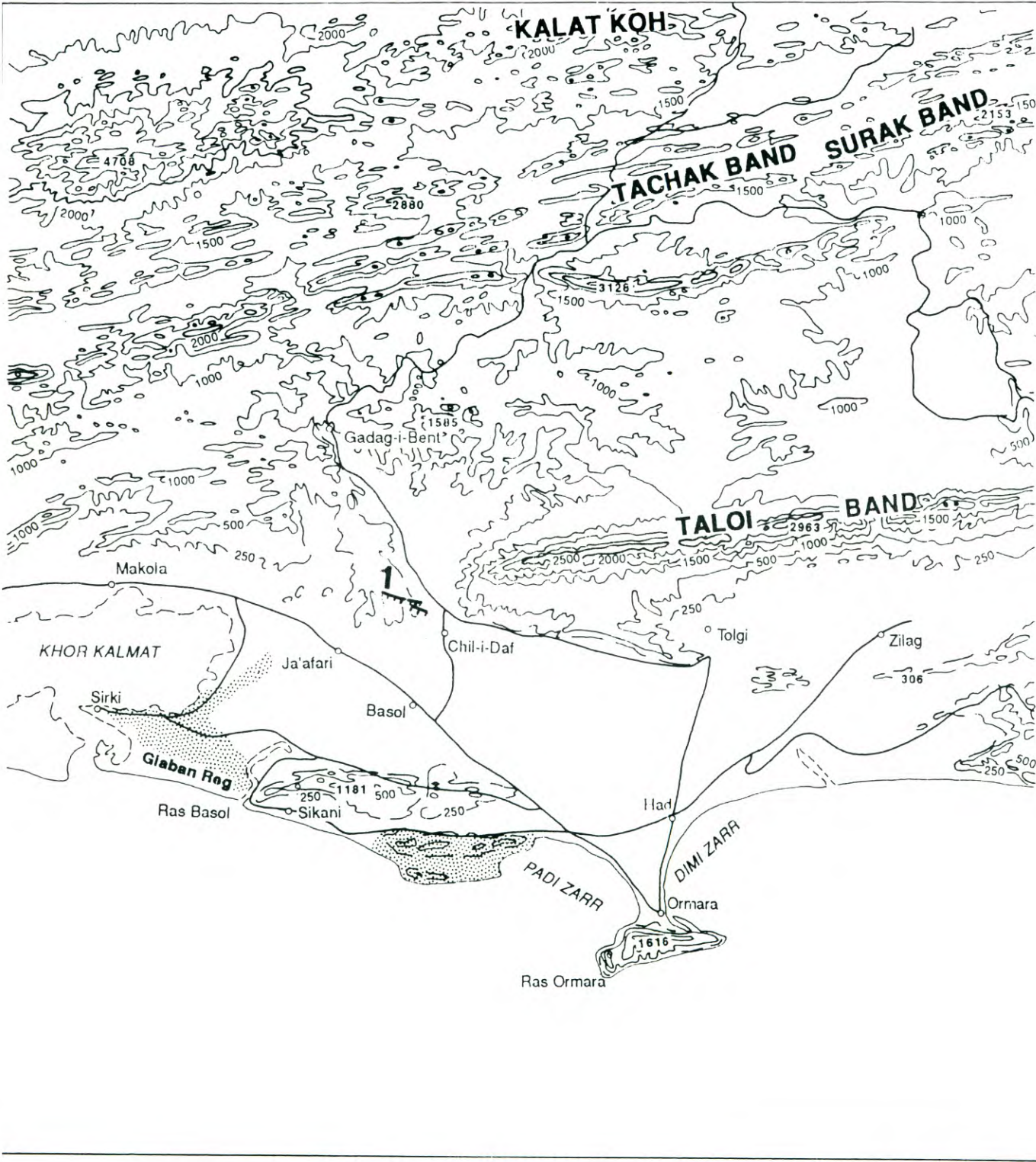


This map-area lies in the Makran Flysch Belt in which Oligocene marine sediments are folded with ENE-WSW trending axes. Most of active faults are located along the fringes of synclinal and anticlinal ridges facing wide valleys filled with Pleistocene fanglomerate. Many dip-slip faults are found to the north, but they are generally short and less certainly active. Only the Matak (4) and Joari (7) Faults exhibit clear class I fault scarplets. On parts of the Hoshab Fault of Kazmi (1979b) several

short, probably active, traces are recognizable along the northern margin of the Kolwa Valley, although most of them are not certain. These are thrust faults on which the northern sides were uplifted. Among them, the Matak Fault (4) displays distinctive fault scarplets that cut Pleistocene fan surfaces. Several NW-SE trending strike-slip fault traces are found along certain tear faults shown on the Hunting Survey's geological map (1960) in the south-western part of the area.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Panjgur	II-III		12.5	ENE	FS,Li	PF	S		
2	Gwar Koh	II-III		15	EW	FS	PF	N, S		
3	Nagak									
	a	II		4	NW	Li, SO	PF, St		R	
	b	II		5	NW	Li, SO	PF, St		R	
	c	II		3	NW	Li, SO	PF, St		R	
4	Matak	I-II	C	9.5	NE	FS	PF	NW(PFm-PFh: 10-15)		
5	Bizhban Chah			14						
	a	II-III		2	NE	FS	PF	NW		
	b	II		5	NE	FS	PF	SE		
6	Ghichak	II-III		12	EW	FS	PF	N		
7	Joari	I-II	C	4	NE	FS	HF,PF	NW(PFI-H: 0.3), SW		Cluster of active faults
8	Malar	II		1.5	NE	FS	PF	NW		
9	Chamburi Kalat	II		4	NE	FS	PF	NW		

35C Ormara • 25-26° N by 64-65° E



Active faults are rare in this map-sheet. The only one found is the Chil-i-Daf Fault (1) on the Pleistocene fan surfaces on the right bank of Basol River. Three class I WNW-ESE trending traces dislocate the fan surfaces up to the north. Though the traces are sharp and clear, the amount of displacement of the

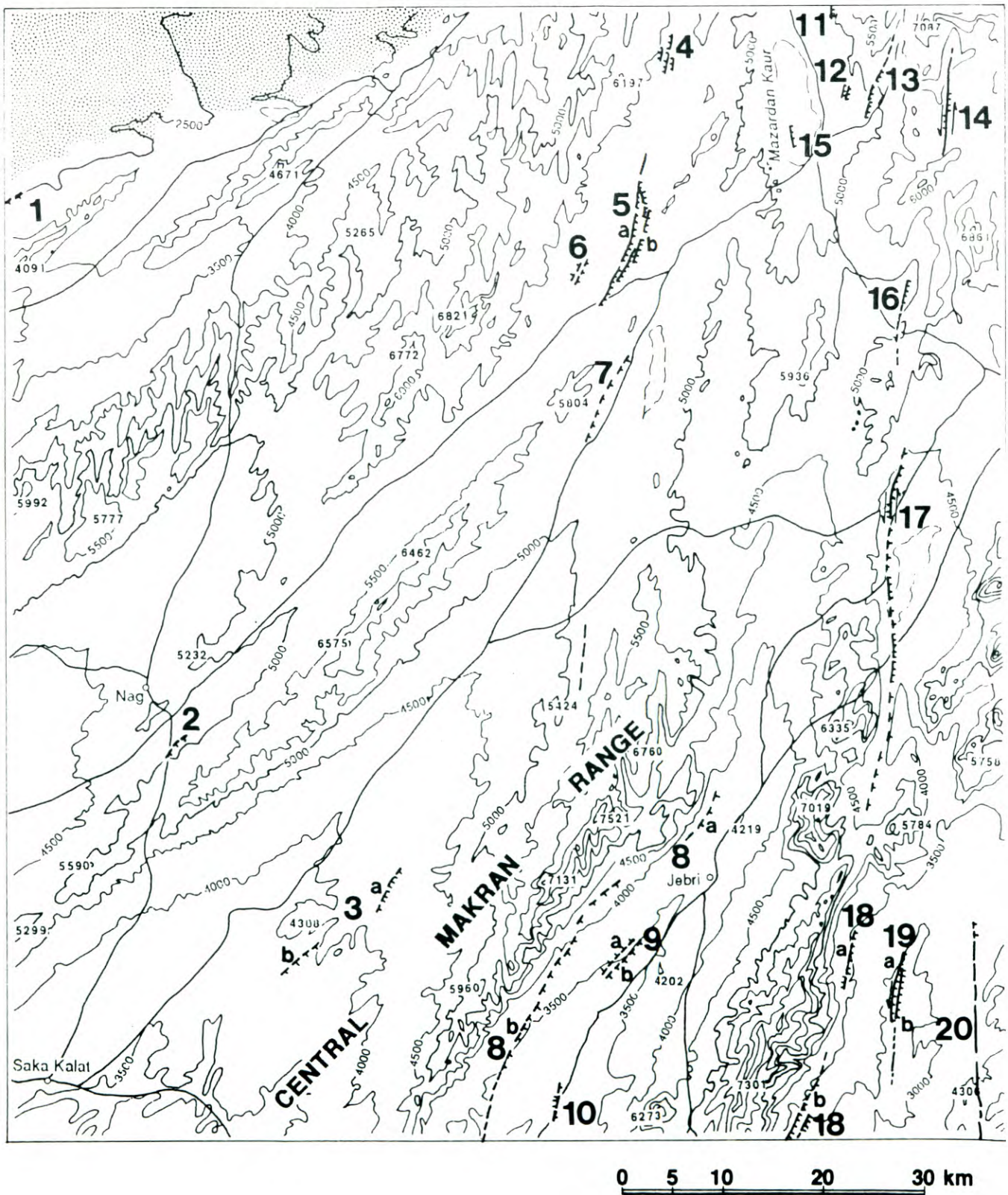
younger Pleistocene is only 1-2 m suggesting a low activity for the fault. Snead (1967) reports that fishermen claim that Ormara Peninsula was uplifted during the 1945 earthquake. The southern part of the peninsula is made up of Pleistocene marine terraces indicating cumulative seismic uplifts of the area.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Chil-i-Daf	I	C	4	WNW	FS	PF	N(PFh:1-2)		



Figure 1. Landsat image of the Ormara Peninsula on the Makran Coast. The peninsula is reported to have been uplifted during the 1945 earthquake. The Chil-i-Daf Fault is the only confirmed active fault on the image. Landsat MSS 2695-05195-7.

35E Saka Kalat • 27-28° N by 65-66° E



This map-area contains the southwestern part of the Marginal Fold-and-Thrust Belt in the northeast, and the Makran Flysch Belt else-

where. Two different kinds of active faults are displayed in each geological setting. In the Makran Flysch Belt, the faults are of dip-slip

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Greshag	II	C	(2)	NE	FS	PF	NW(0.5-1)		35A(4),total 4km
2	Nag	II	C	2.5	NE	FS	PF	NW(PFh: 3-5)		
3	Zung			17						
	a	I-II	C	4	NE	FS	PF	NW(PFhh: 10, PFh: 2-3)		
	b	II		4	NE	FS	PF	NW		
4	Gati	I	B	2	NNE	FS	PF	E(10-15)		Parallel fault traces
5	Shireza			17						
	a	I	B	16	NNE	FS	PF	W(PFhh: 5-7)		
	b	I	B	9	NNE	FS	PF	W(PFhh: 3)		
6	Rez	II		2.5	NE	FS, Ho	PF	NW(3-5), SE		Parallel traces
7	Shaikh Palli	II-III		9	NE	FS	PF	NW		
8	Mashkai Valley			(30)						
	a	II		3	NE	FS	PF	NW		
	b	I-II		30	NE	FS, Wa	PF	SE, NW		
9	Gajar			4						
	a	II		4	NE	FS	PF	SE		
	b	II		4	NE	FS	PF	NW		
10	Bansar	I-II	B	3	NNE	FS	HF	W, E(5)		
11	Durman	I	B	2	NS	FS	PF	W(1-2)		
12	Sanjit	I	B	1.5	NS	FS	PF	W(2-3)		
13	Katgali	I	B	8	NNE	FS	PF	W(15)		
14	Ghazaband	I	B	(12)	NS	SO, FS, PR	St, PF, HF	W(PFm: 10), E(PFh: 1)	L(30)	34H(8), 34K(11), 34L(2)
15	Mazardan	I-II		5	NS	FS, Li	PF	W(PFh: 10, PFm: 2)		
16	Kodak	I-II	B	5	NNE	FS	PF	W(PFh: 5), E		
17	Gawani Kalat	I-II	B	35	NS	FS, SO	PF, St, MS	W(PFhh: 10), E(PFm: 2-3)	L	
18	Churchuri			(22)						35F(9), total 55km
	a	I	B	5.5	NNE	FS	PF	W(PFm: 2-3), E(PFm: 2)		
	b	I-II	B	9.5	NE	FS	PF, HF	W(PFh: 3-10)		Parallel traces
19	Hudeshi			10					L	HSC (1960)
	a	I	B	7.5	NNE	FS, SO	PF, St	W(5)	L(40)	
	b	I-II	B	9	NS	FS, Li	PF	W(PFh: 10-15)		
20	Fudeshi East	II-III		22	NS	FS, Li	PF	W(PFm: 2-3)		35F(10), total 36km

35E Saka Kalat

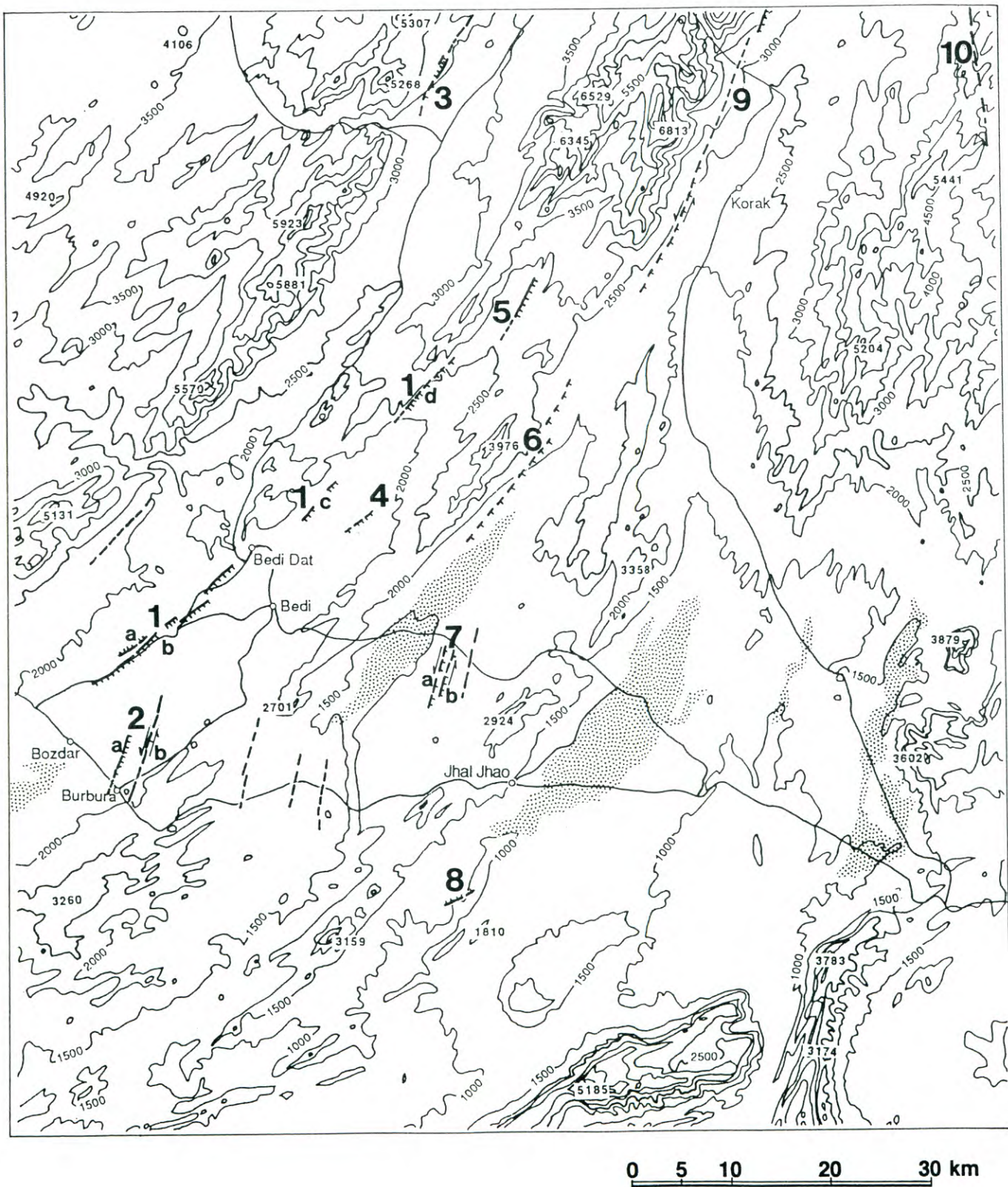


type, but their orientation changes from N-S in the east to NE-SW in the west. Among these, the Gati (4) and Shireza (5) Faults are class I and clearly dislocate Pleistocene fan surfaces. Mashkai Valley Fault (8) in the south may be a segment of the Hoshab Fault of Kazmi (1979b). The active faults in the fold-and-thrust belt, in contrast to the name of the zone, are of strike-slip type. They extend N-S parallel to the

Ornach-Nal Fault of map sheet 35I. They are located on geologically mapped faults. Among them, the Hudeshi Fault (19) was recognized as active by the Hunting Survey (1964) and Kazmi (1979b). Distinctive stream offsets and young fault scarplets on Holocene fan surfaces along them indicate very recent displacement on them.

Figure 1. Landsat image of the northeast end of the Makran Ranges (Map sheet 35 E) and north end of the Ornach-Nal Fault (1 on Map sheet 35I). The active trace of the Gawani Kalat Fault (17) shows particularly well as a very straight feature cutting Quaternary fan material at about the center of the image. Landsat MSS 2658-05151-7.

35F Jhal Jhao • 26-27° N by 65-66° E

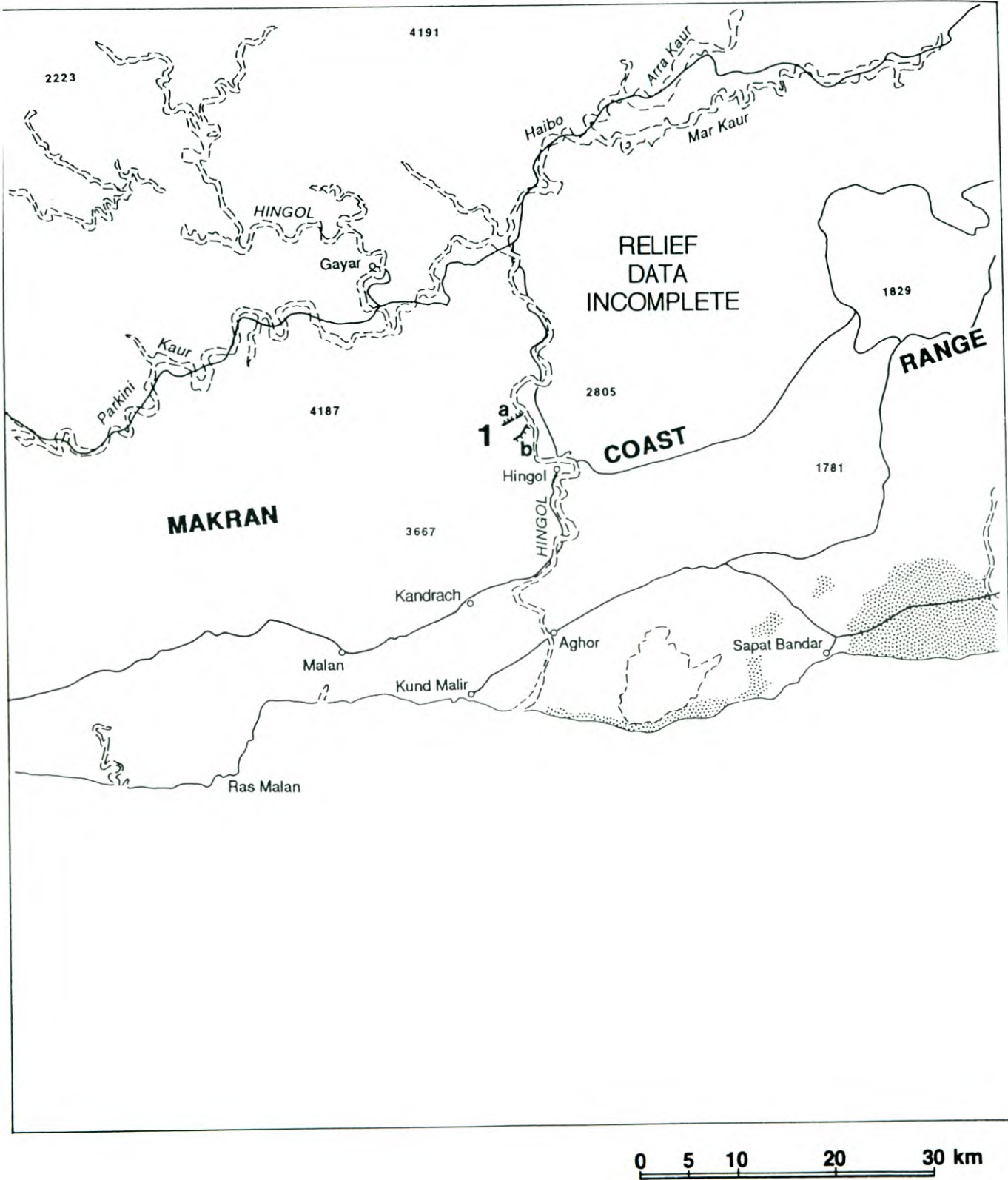


This map-area is characterized by NE-SW trending reverse faults and NNE-SSW trending left-lateral strike-slip faults. The former are parallel to fold axes and generally follow geologically mapped faults, which make topographical boundaries between bedrock anticlinal mountains and alluvium covered, longitudinal, and probably synclinal, valleys. The most prominent among them, the Bedi Dat Fault (1), is composed of several segments along which Pleistocene fan surfaces are dis-

placed, generally up to the west. In the southwestern part of the area, several NNE-SSW trending tear faults mapped by Hunting Survey (1960) show recent displacement and stream offsets suggest left-lateral motion on them. The western trace of Burbura Fault (2) may coincide with the trace of Bazdar Fault of the Hunting Survey (1960) and Kazmi (1979b). Along the southern part of the Churchuri Fault (9), stream offsets also display left-lateral slip.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Bedi Dat		C	50						
	a	I	C	3	NE	FS	PF	SE(PFh:10)		
	b	I-II		20	NE	FS,Back-Ti	PF	NW(PFh:7-12)		
	c	I		6	NE	FS	PF	NW		
	d	I-II		9	NE	FS	PF	NW(PFf:2-3)		
2	Burbura			12						
	a	I-II		6	NNE	FS,Li	PF	W(PFm:5)		
	b	II	B	10	NNE	LV,FS,SO	PF,V,St,MS	W	L(200)	
3	Mashkai Valley		B							
	a	I-II		6	NE	FS	PF	NW(PFf-m:2)		
	b	I-II	B	6	NE	FS,Ho	PF,HF	SE(1-2),NW		
4	Husaini Ghah West	I-II		3	NE	FS	PF	NW(1)		
5	Daraj	I	B	7	NE	FS	PF	NW(PFm:5)		
6	Husaini Ghah East	II-III		20	NE	FS	PF	NW		
7	Aundara		B							
	a	I-II		6	NNE	FS,SO,LV	PF,St,V	W(PFf:1-2)	L	
	b	I	B	5	NNE	FS,SO,LV	PF,St,V	W(2-3)	L	
8	Jhao	I-II	B	3	ENE	FS	RT,PF	S(PFm:1-2)		
9	Churchuri	I-II	B	(32)	NE	FS,SO	MS,St,PF	NW(PFh:10), SE	L	35E(18), total 55km
10	Hudeshi East	III		(14)	NS	Li	MS,St			35E(20), total 36km

35G Kandrach • 25-26° N by 65-66° E



The only active fault found in this map-area is the Hingol Fault (1) which is composed of two short NE-SW trending parallel traces. It dislocates Pleistocene fan surfaces up to the

north along the southern trace and up to the south along the northern trace. Mud volcanoes found in this area are also related to recent tectonics.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Hingol									
	a	I-II	C	2	ENE	FS	PT	SE(PTm:3)		
	b	I-II	C	1.5	NE	FS	PT	NW(PTh:10)		

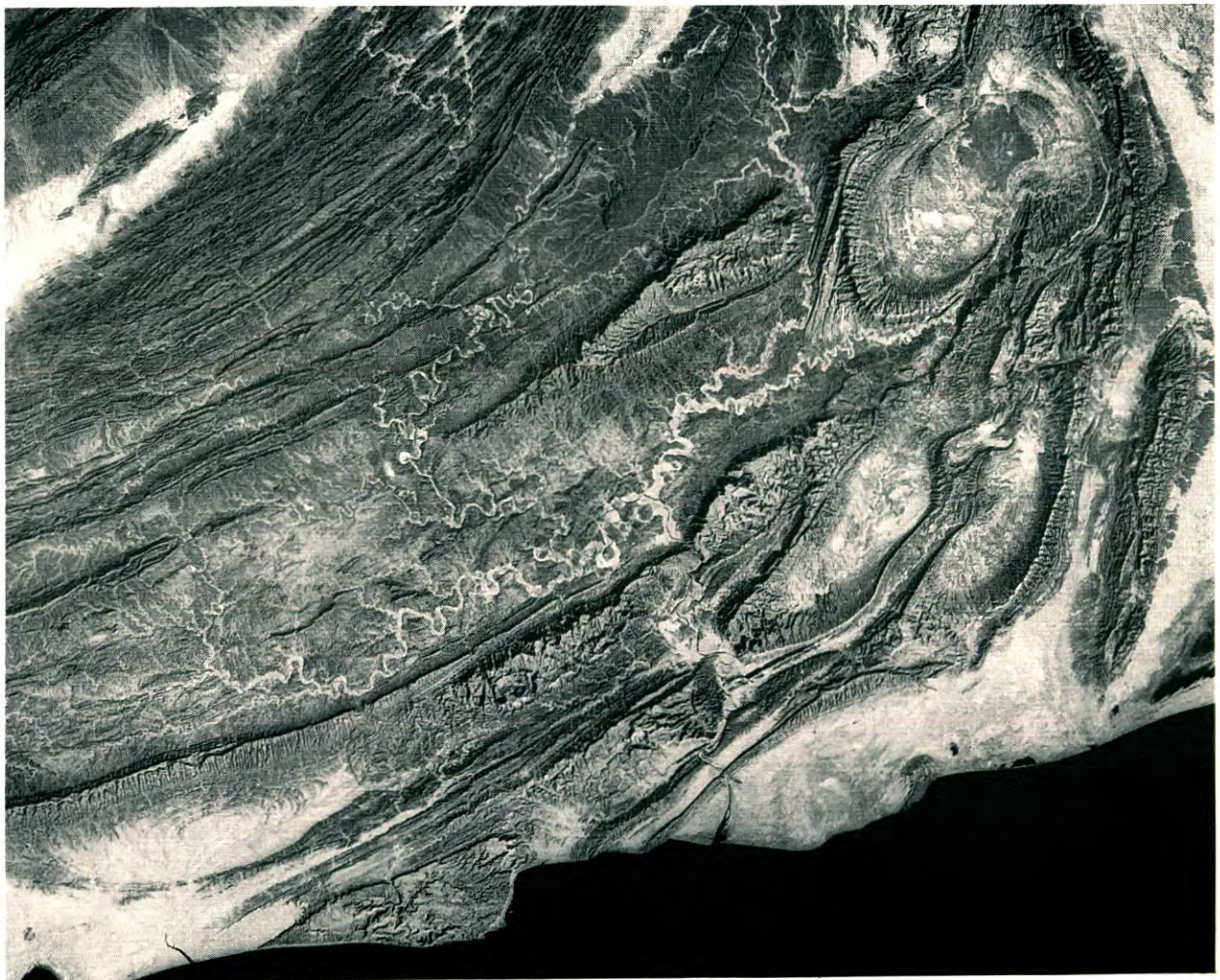


Figure 1. Landsat image of the Makran Coast Range in the Kandrach area. The large folds are synclines in Late Miocene sediments. The ridge just south of Kandrach town is formed of extrusive mud from mud volcanoes located along a fault. Landsat MMS 2658-05154-7.

35I Khuzdar • 27-28° N by 66-67° E



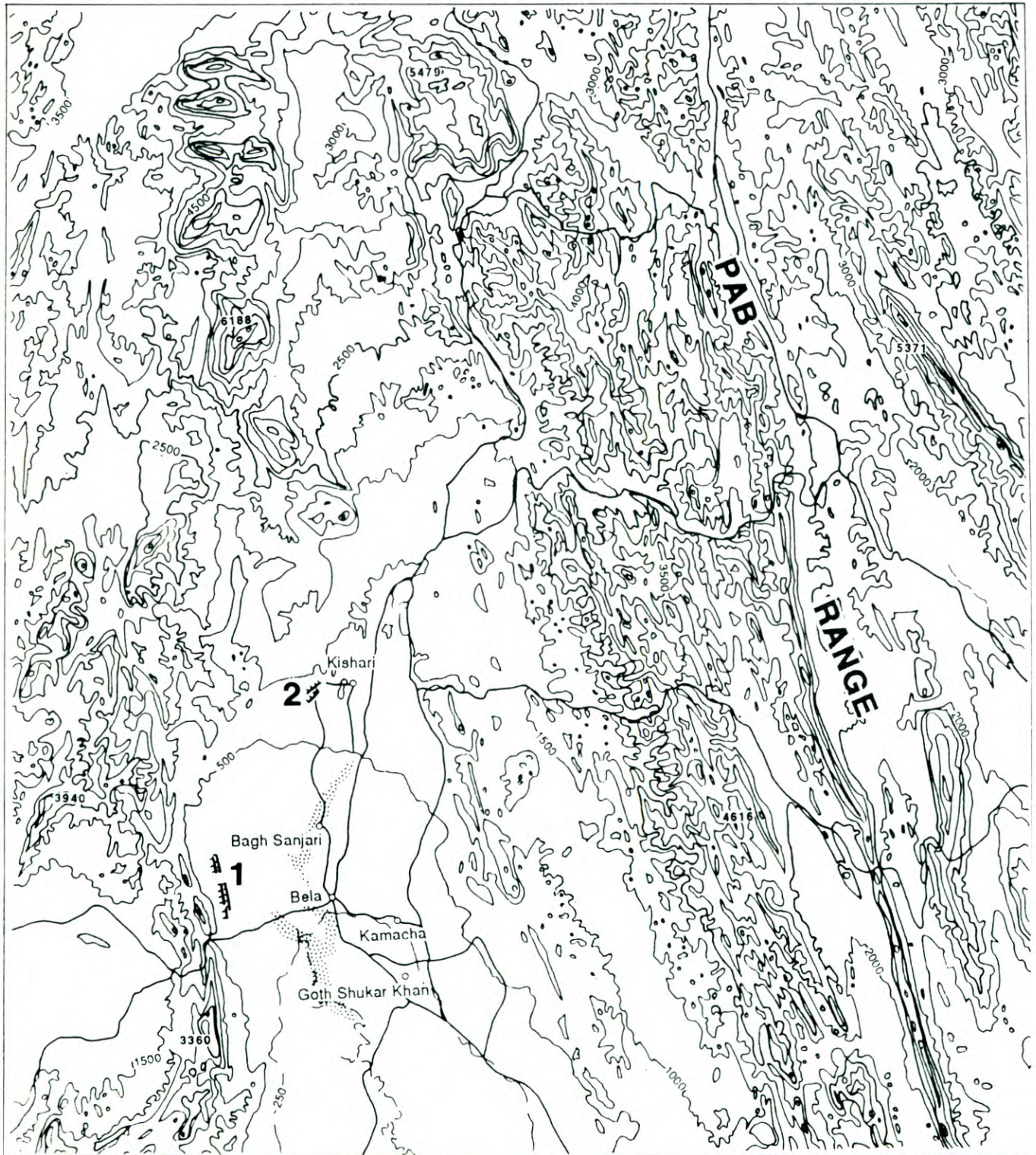
The Ornach-Nal Fault (1) is an active left-lateral strike-slip fault, which has been well known since the Hunting Survey (1960) discovered it. The northern segment, independently named the Pariko Fault (3), is separated from Ornach-Nal by a gap of 15 km. The Ornach-Nal Fault extends for about 160 km in the N-S direction, but it is not clear topographically for the southern 50 km. The sense of apparent movement is left-lateral with small vertical components which vary up to the east in some places and up to the west elsewhere.

North of Haji Karan Khan, a graben was formed between two parallel antithetic traces. The fault traces are generally straight, and the fault dips nearly vertically.

In the northeastern part of the area, south-east of Khuzdar and within the Kirthar Fold Belt, several active dip-slip faults extend ENE-WSW to E-W. Though they are short, up to 5 km long, and are not consistent with any geological trends, their certainty is high and recent movements are proved by scarplets of faulted Pleistocene fans.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Ornach-Nal			(85)						34L(8), total 90km
	a	II-III		10	NNE	LV,SO,FS	HSV,St	E	L	
	b	I	B	5	NS	FS,SO,LV	PF,St,V	E(2-3)	L(60)	
	c	I	B	1.75	NW	FS	PF	NE(10-15)		
	d	I-II		1.25	NS	FS	PF	E		
	e	I	B	11	NS	FS	PF	W(PFm: 10, PFl: 2-10)		
	f	I	B	22	NS	FS,SO,Gr	PF,St	E(PFh: 30, PFm: 10), W(PFl:5)	L(100)	Parallel traces
	g	I-II		10	NS	FS,LV	PF,V	E,W		
	h	I-II	B	2	NS	FS	PF	W(PFh: 10)		
2	Magando	II		1	NS	FS	PF	E		
3	Pariko	I-II	B	8	NE	FS	PF	NW, SE(PHf: 10)		
4	Katham	I	B	1.2	EW	FS	PF	S(PFm: 5-7)		
5	Khuzdar	I	B	4.5	NNE	FS	PF	E(PFm: 5-10)		
6	Kani Jhal	II-III		5.5	NE	FS	PF	SW		Cluster of fault traces
7	Kandi Jhal	I	C	4	NE	FS	PF	SE(PFm: 3-5), S(PFh: 5-10)		
8	Wad Thana	II		11	NNW	FS	PF	W		
9	Zidi	I	B	5	NE	FS	PF	NW(PFm :10, PFl: 1-2)		Parallel traces

35J Bela • 26-27° N by 66-67° E



A horizontal number line with tick marks at 0, 5, 10, 20, and 30 km.

Development of active faults in this map-area is quite limited, although it is located close to the triple junction of the Indian, Arabian, and Eurasian Plates. Only two active faults of dip-slip type were found: the Bela Fault (1) is located just west of Bela town along the eastern fringe of the Halar Range, and the Kishari Fault (2) is just west of Kishari town. The

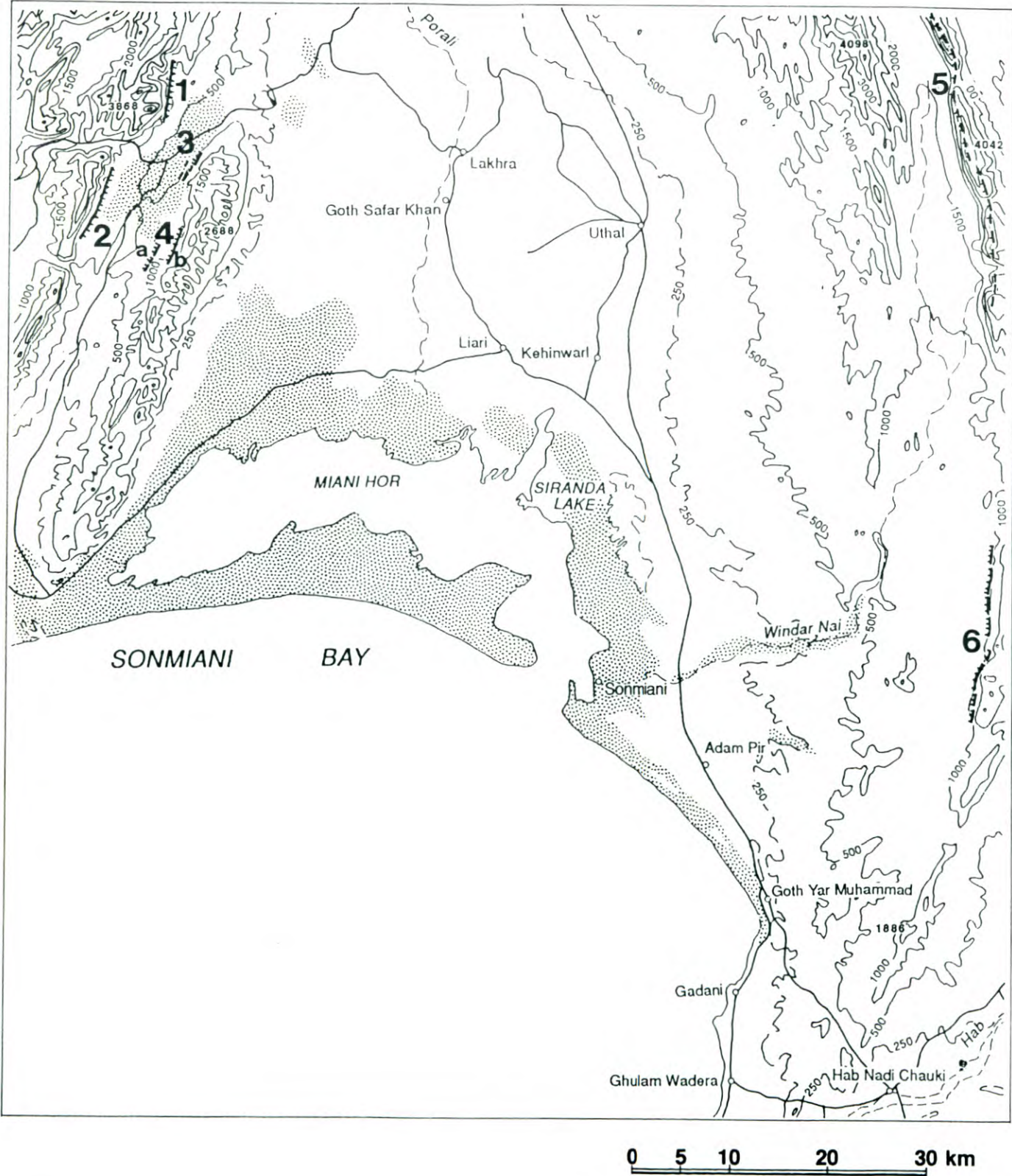
former is composed of three short N-S striking parallel traces probably along bedding planes. Pleistocene fan surfaces are displaced up to the east by small amounts. The latter extends NE-SW and displaces the Pleistocene fan surface up to the south. The fault consists of two short parallel trending segments.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Bela	I	C	7	NNW	FS	PF	E(PFh: 2-5)		Several parallel bedding faults
2	Kishari	I-II		4	NE	FS	PF	SE		Parallel traces



Figure 1. Landsat image of the Bela area along a portion of the Ornach-Nal Fault without clear evidence of recent activity. Along the western margin of the Bela Plain Quaternary sediments are actively tilted adjacent to the mountain front. The distance between the crosses is 10 km. Landsat RBV 31311-05245-B.

35K Sonmiani • 25-26° N by 66-67° E



This map-area with many active faults lies near the triple junction between the Arabian, Indian and Eurasian Plates. In the northwestern part of the area, the Chilro (1), Laloi Koh (2), Bambo (3), and Haro (4) Faults are located along the boundary between Arabian and Eurasian Plates. They follow geologically mapped faults in Hinglaj Group. These faults occur along the limbs of what is probably a synclinal valley, and so they may be bedding plane faults related to flexural-slip folding. These NNE-SSW striking faults are located near the

southern extension of Ornach-Nal Fault. They, however, displace Pleistocene fan surfaces and mountain slopes only vertically not horizontally. Mud volcanoes also indicate neotectonic activity in this area.

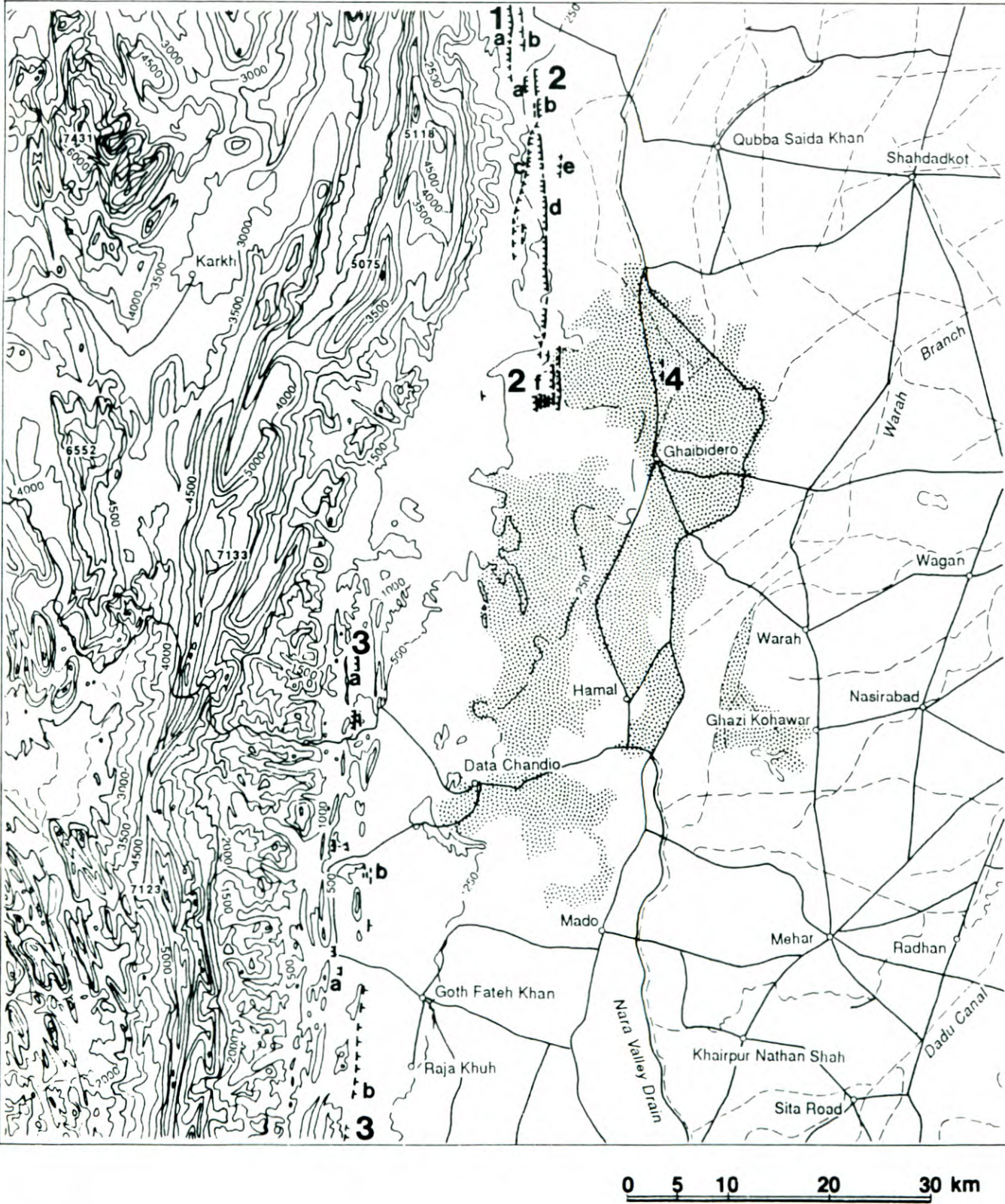
On the eastern fringe of the area, the Windar Valley (5) and Pab Range Front (6) Faults are along the western foot of the Pab Range and probably follow geologically mapped faults in the Parh Group. These active faults vertically dislocate Pleistocene fan surfaces up to the east.

#	Fault Name	Class	Act t	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Chilro	I		6	NS	FS	PF	W(PFm: 15)		
2	Laloi Koh	I	B	9	NNE	FS	PF	W(PFm: 5-10)		
3	Bambo	I-II		3	NE	FS,Gr	PF	E(PFm: 5)		Parallel traces
4	Haro a b	I-II		2.5	NNE	FS	PF	E		
		I		4	NNE	FS	PF	E(PFm: 10)		
5	Windar Valley	II-III		30	NNW	FS,Li	MS	E		
6	Pab Range Front	I	B	20	NS	FS	PF	E(PFm: 5-10)		



Figure 1. Landsat image of the Sonmiani Bay area. Four active faults are present in the west. Two active faults occur in the Pab Range on the east. Landsat MSS 2693-05082-7

35M Mehar • 27-28° N by 67-68° E



The north-south Kirthar Range Front occupies the center of this map-area. It is composed of monoclinal and anticlinal structures probably still actively forming over blind thrust faults. Active faults are concentrated along the foot of the front and run parallel to the axes of folds and strikes of beds. Pleistocene fan surfaces are generally vertically dis-

placed up to the east along parallel or sub-parallel traces. These appear as reverse scarplets that are probably related to bedding plane faults created during active flexural-slip folding. Active faults are less clear in the southern half of the map-area, although some of the traces exhibit sharp fault scarplets.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Haji Khan		B	(48)						35M(3), total 96km
	a	I		6	NS	FS	PF	W(PFm-h: 15), E(PFh: 15)		Parallel traces
	b	I	B	10	NS	FS	PF	E(PFm: 1-2, PFh: 10-15)		Parallel bedding faults
	c	I-II		(48)	NS	FS,Ho	MS, RT, PF	W(PFm: 5-15), E(PFh: 2-3)		
2	Pir Ghazi		C	25						
	a	I-II		3	NW	FS	RT	NE		
	b	I-II		10	NW	FS,Ho,Wa	RT, PF	SW(PFh: 15), NE		Active folding
3	Tirath Laki	I-II	B	21	NS	FS,Ho	MS, RT, HF, PF	W(PFm: 5-10, PFh: 30)		Parallel traces



Figure 1. Landsat image of the Kirthar Range Front. Landsat MSS 2693-05080-7

35N Dadu • 26-27° N by 67-68° E

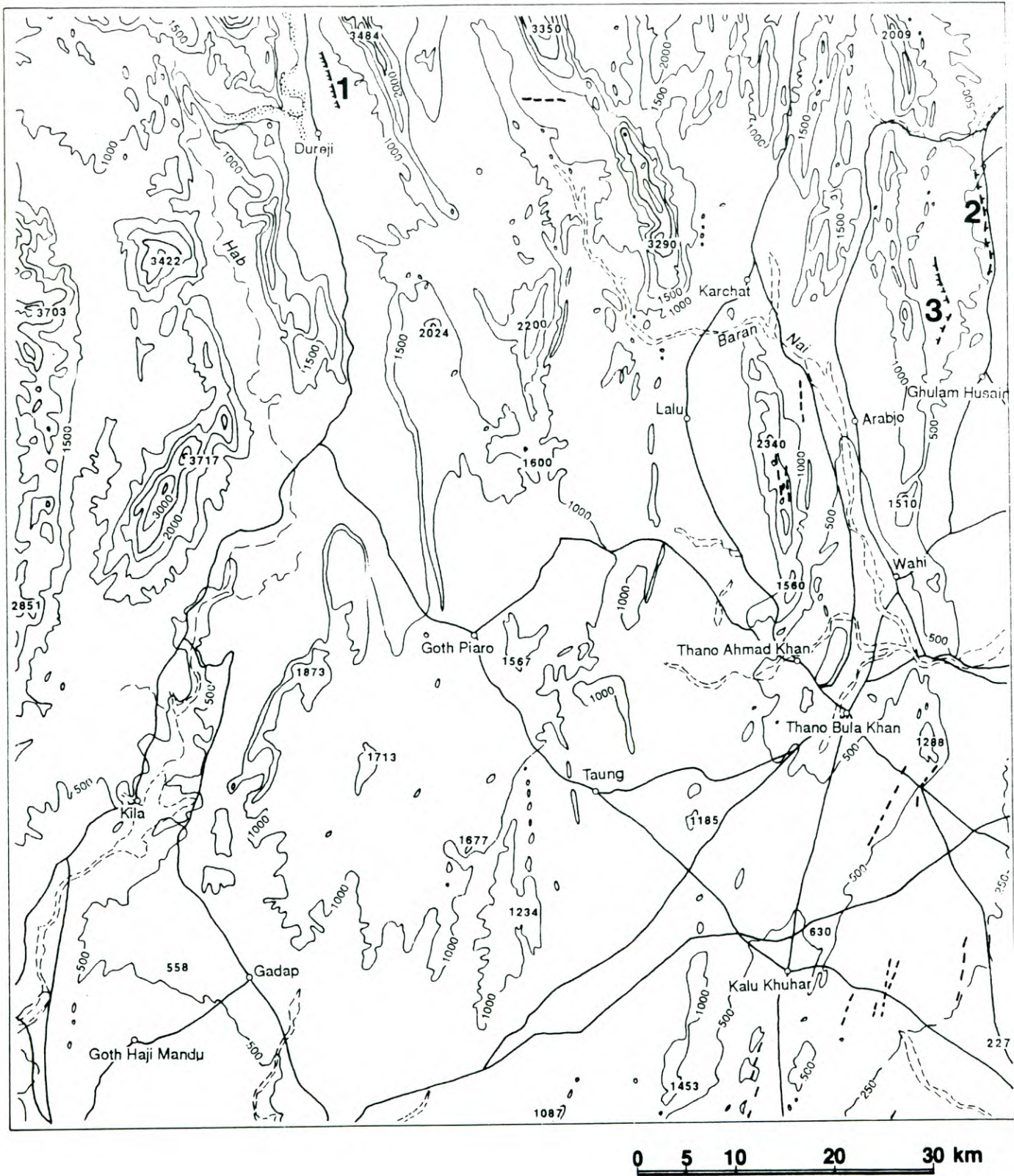


Active faults in this map-area are characterized by a series of short intermittent traces parallel or subparallel to N-S striking cuestas. Active faults are confined to a 5 km wide zone along the eastern fringe of Kirthar Range at the boundary between the mountains and the

Indus Plain. Many bedding-parallel faults in the Pliocene Manchar Formation, which is composed of continental deposits, probably reflect active flexural-slip folding over a blind thrust tip. Piedmont deposits are sharply tilted eastward along the foot of the range.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Haji Khan		B	(48)						35M(3), total 96km
	a	I		6	NS	FS	PF	W(PFm-h: 15), E(PFh: 15)		Parallel traces
	b	I	B	10	NS	FS	PF	E(PFm: 1-2, PFh: 10-15)		Parallel bedding faults
	c	I-II		(48)	NS	FS, Ho	MS, RT, PF	W(PFm: 5-15), E(PFh: 2-3)		
2	Pir Ghazi		C	25						
	a	I-II		3	NW	FS	RT	NE		
	b	I-II		10	NW	FS, Ho, Wa	RT, PF	SW(PFh: 15), NE		Active folding
3	Tirath Laki	I-II	B	21	NS	FS, Ho	MS, RT, HF, PF	W(PFm: 5-10, PFh: 30)		Parallel traces

35O Thano Bula Khan • 25-26° N by 67-68° E

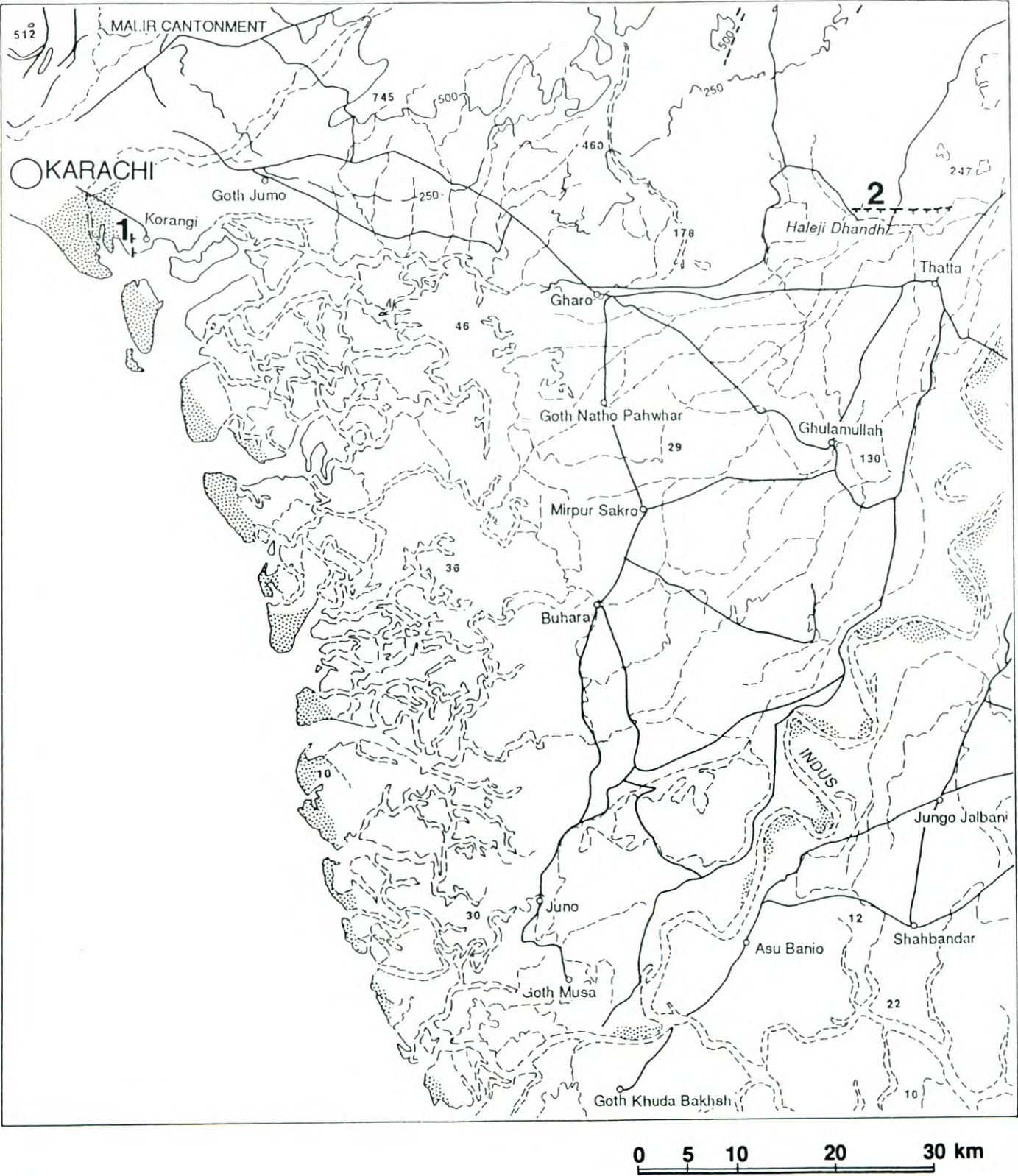


There are many sharp lineaments which parallel the trends of geological structures of southern Kirthar Fold Belt in this map-area. Among these lineaments, the Dureji (1), Bhit (2), and Budha (3) Faults are probably active.

Along them, Pleistocene fan surfaces are displaced and fault scarplets and flexure scarps developed. These features are very distinctive, but one cannot completely neglect a possibility of an erosional origin for them.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Dureji	I-II	B	6	NNW	FS	PF	E(PFhh: 30, PFh: 10)		
2	Bhit	II	C	10	NS	FS,Wa	PF,MS	W(PFh: 15)		
3	Budha	I-II	C	10	NS	FS	PF	E		

35P Karachi • 24-25° N by 67-68° E



In this map-area, no active faults are recognized with a high degree of certainty. Two lineaments could be possibly active. One is the Korangi Fault (1) located east of Karachi. This is a N-S lineament along which a fault scarplet

has formed on the coastal plain. The other possibly active lineament extends along the southern margin of the Kirthar Fold Belt and has an E-W scarplet along the beach ridge.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Korangi	II-III		2	NS	FS	Coastal Plain	W		
2	Thatta	II-III		10	EW	FS	Beach Ridge	N		



Figure 1. Lansat image of the Karachi area and the northwestern corner of the Indus Delta. Landsat MSS 2675-05094-7.

38G Gardez • 33-34° N by 69-70° E



This map-area, mostly in Afghanistan, has an E-W trending distinctive active fault north of Ali Mangal Post at the base of Safed Koh. It displaces a Pleistocene fan surface up to the north as much as 30 m. It is the western extension

of the Parachinar Fault (1), located on the Parachinar-Murree Fault of Kazmi and Rana (1982). In Afghanistan, this fault is commonly referred to as the Safed Koh Fault.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Parachinar	I	B	(8)	WNW	FS	PF	N(25-30)		38K(1),total 20km

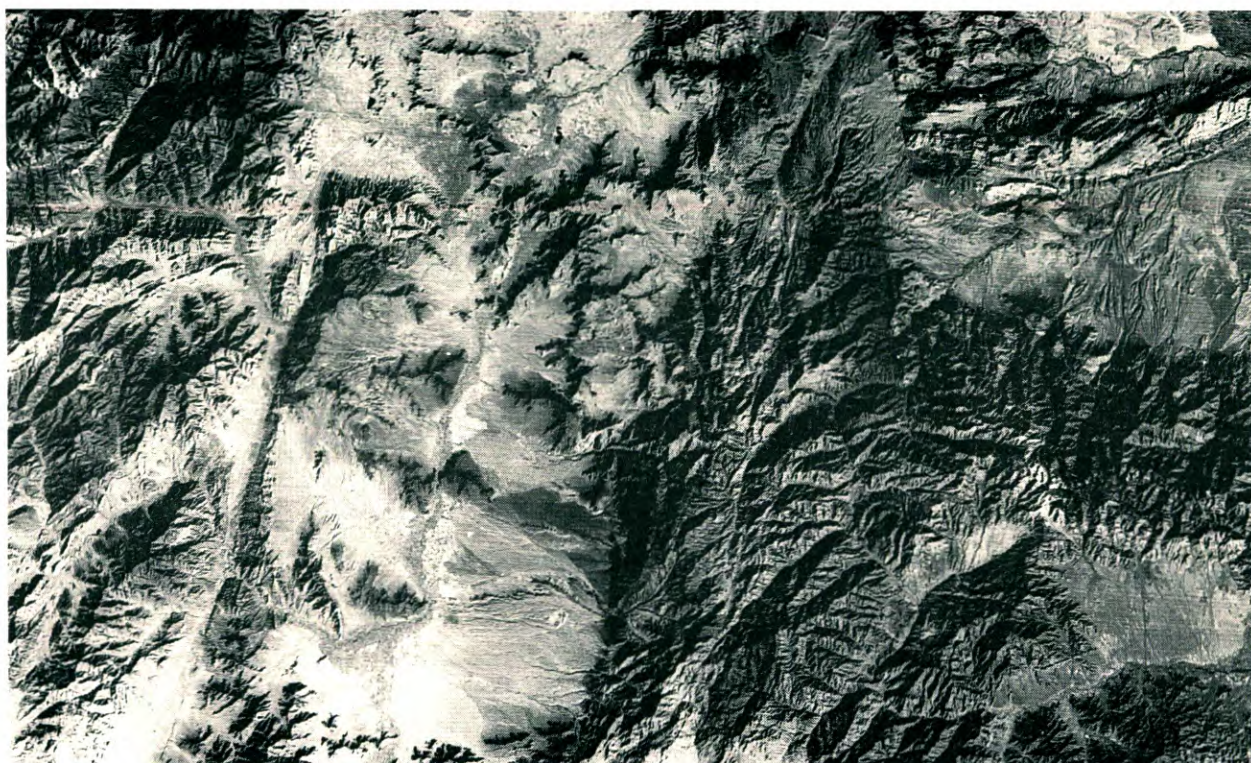


Figure 1. Landsat image of the western Parachinar area and adjacent Afghanistan. The west end of the Parachinar Fault is present. On the west side of the image the north end of the Chaman Fault, which broke during a great earthquake in 1505 with major destruction around Kabul, is visible. Landsat MSS 2675-05064-7

38H Wana • 32-33° N by 69-70° E

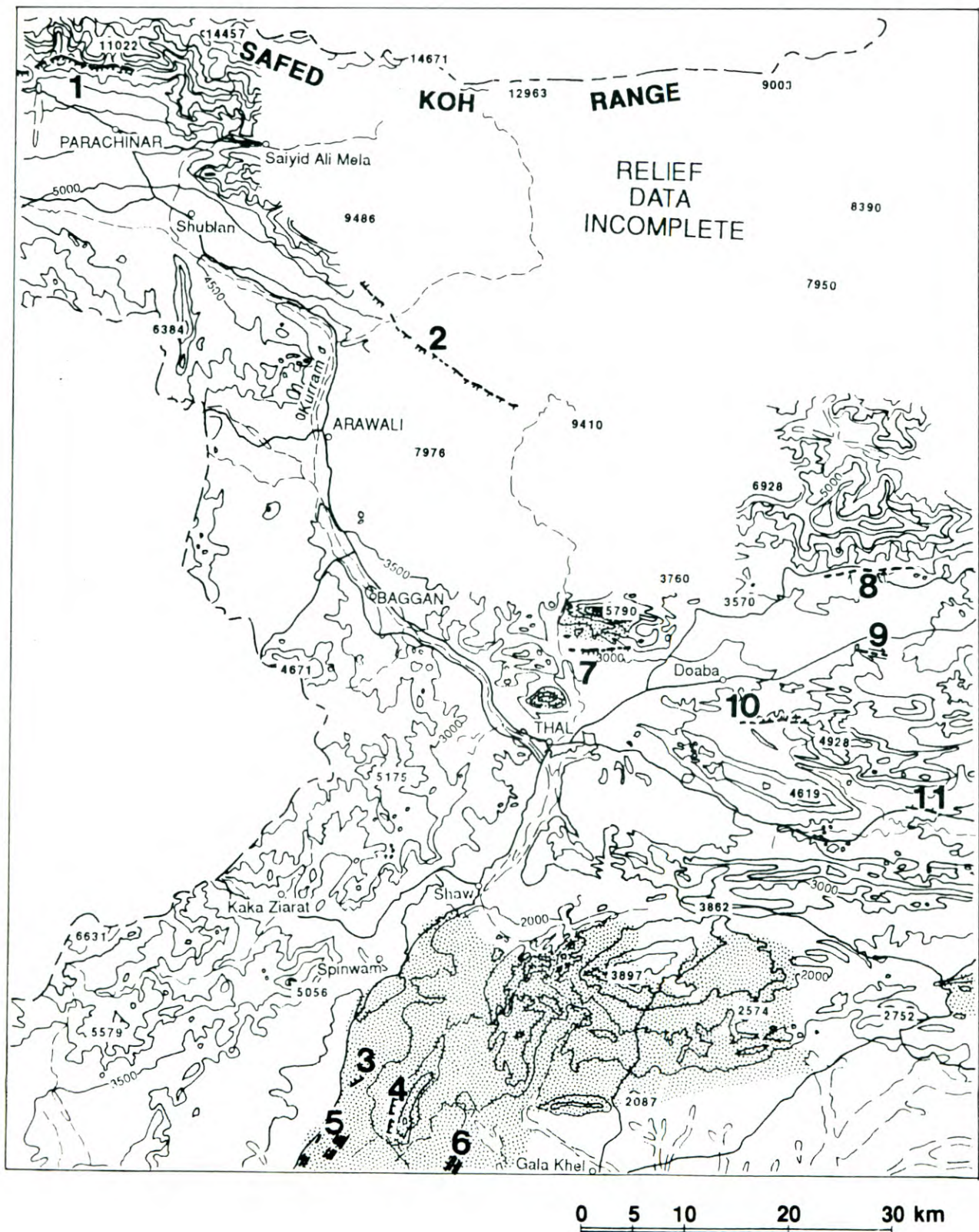


In this map-area, there are several active dip-slip faults come in two groups. One extends roughly in the E-W direction in the ophiolite zone, and the other extends in the N-S direction along the poorly known Waziristan Fault (DeJong, 1982), which follows the ophiolite belt between the Marginal Fold-and-Thrust

Belt and the Khojak Flysch Belt. The former ones are short intermittent faults for which the evidence of recent activity is uncertain. The latter ones are composed of a series of short faults running parallel to each other along which Pleistocene fan surfaces are vertically dislocated with varying uplifted sides.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Tumankai			(10)						39E(2), total 82 km
	a	I		3	NS	FS	PF	E		Parallel traces
	b	I		3	NNW	FS	PF	E,W		
	d	I	B	2	NS	FS	PF	E		
	c	I	B	2	NS	FS	PF	W		Parallel to sub-parallel traces
2	Shina	II		5	WNW	FS,Wa	PF	N,S		
3	Zorum Achan	I-II	C	2	NE	FS	PF	NW		
4	Kotai Kili	II-III	C	7	WNW	FS	PF	N		
5	Dargai Oba Post	II-III	C	6	NNW	FS	PF	W		

38K Parachinar • 33-34° N by 70-71° E

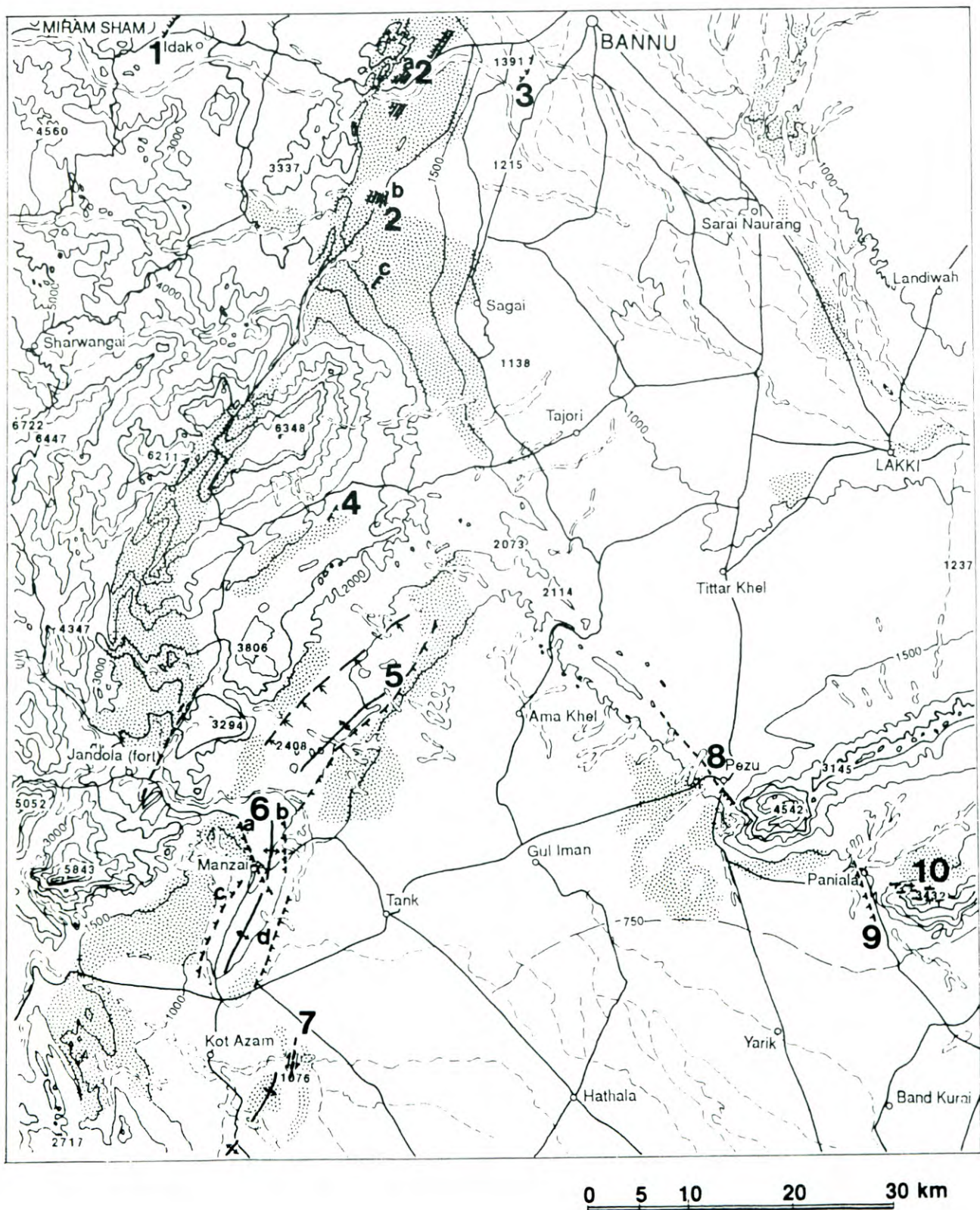


In the northwest corner of this map-area at the base of Safed Koh, the Parachinar Fault (1) is a distinctive active thrust along which Pleistocene fan surfaces have been cumulatively dislocated up to the north. The total length of this fault is over 20 km, including its western extension in 38G sheet. Arawali Fault (2) is a chain of intermittent short traces trending NW-SE, which may follow one of the major thrusts in Parachinar-Kala Chitta Fold Belt. Southeast of the Arawali Fault, several E-W

trending lineaments, which are parallel to fold axes in the belt, are probably active. Although the evidence is not clear for most of their length, small portions of their traces indicate recent activity by fault scarplets on Pleistocene fan surfaces. Clusters of parallel faults, striking NE-SW or N-S, occur in the southern portion of the area. These are bedding faults and form clusters in an area about 3 km across associated with flexural-slip in active synclines.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Parachinar	I	B	(12)	EW	FS	PF	N(PFm:10-20)		38G(1),total 20km
2	Arawali	I	B	20	NW	FS	PF	NE(PFm:10-15), SE(PFm:10)		
3	Bobal	I		2	NE	FS	PF	SE		
4	Muchal Mela	I-II		3	NNE	FS,Ti	PT	W		
5	Gheri Pal	I		5	NE	FS,Ho, Gr	PT	SE,NW		Cluster of bedding faults
6	Dreghundai	I		(2)	NE	FS	PT	SE		Cluster of bedding faults, 38L(2)
7	Thal	I-II	B	6	EW	FS	PF	N(PFm:10-15)		
8	Togh	II-III		8	EW	Li,Ti	MS,PT	S		
9	Khawaja	II-III		3	WNW	Li,SO	St,PF		R	
10	Doaba	I-II	B	6.5	EW	FS	PT,PF,MS	S(PFl:5-10)		
11	Landuki	II		3	WNW	FS	PT	S		

38L Bannu • 32-33° N by 70-71° E

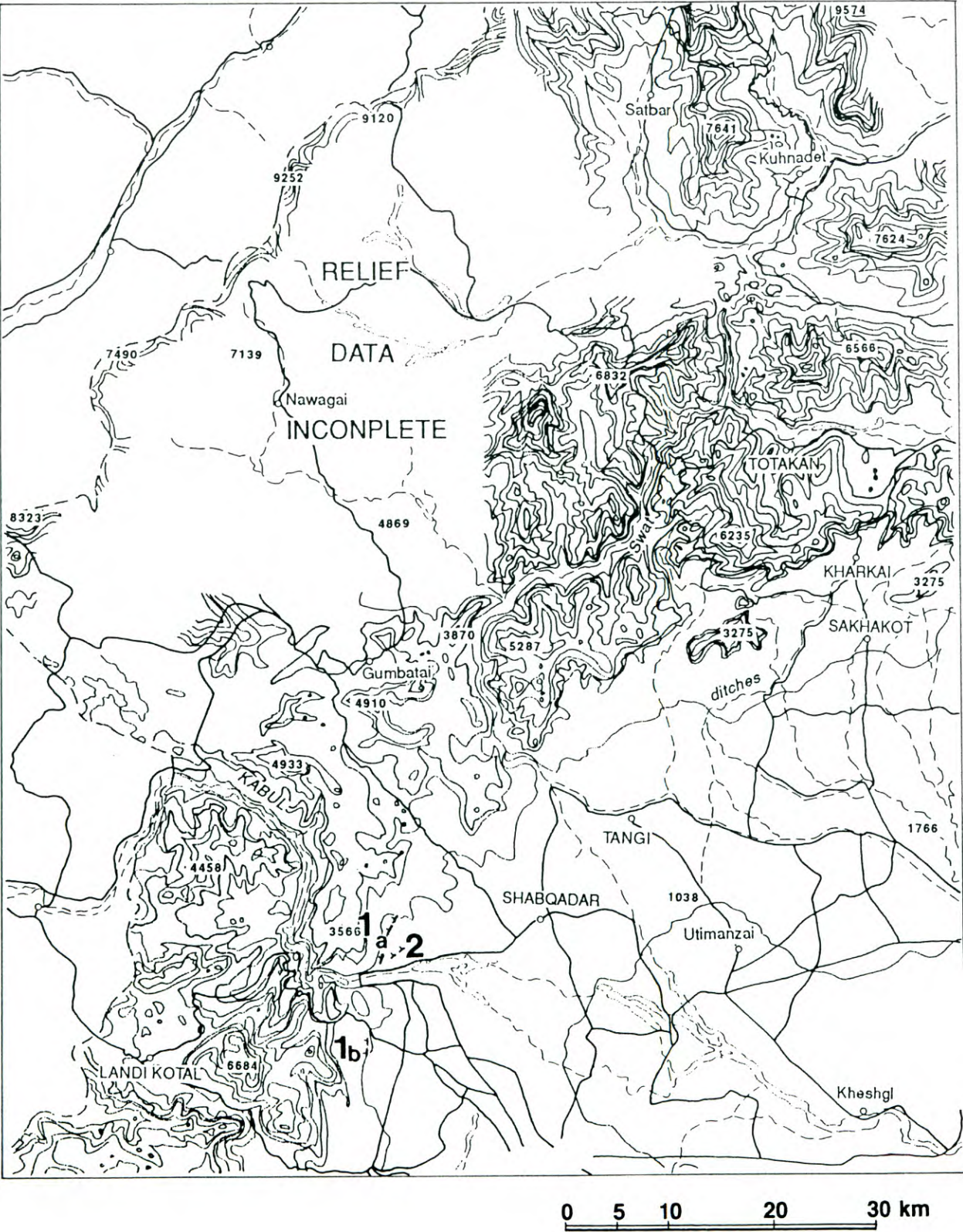


This map-area lies in Marginal Fold-and-Thrust Belt and is characterized by active folding and associated bedding plane faults. Clusters of densely-spaced parallel fault traces of Dreghundai Fault (2) are found in the northern part of the area, west of Bannu. They roughly parallel NE-SW axes of folds. Young

anticlinal ridges have been growing in the plain area off the eastern fringe of the Sulaiman Range, and tectonic features related to warping and tilting are commonly seen on around them. The southwestern flank of Trans-Indus Salt Range is generally marked by obscure fault features except the area south of Pezu.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Daur	I-II	B	2.5	NE	FS	PF	SE		
2	Dreghundai			(28)						38K(6)
	a	I		15	NE	FS	PF	SE(PTm: 1-5)		Cluster of bedding faults
	b	I		1	NS	FS	RT	E		Cluster of bedding faults
	c	I		1	NE	FS	PF	NW		
3	Bannu	II-III	C	3	NE	FS	PF	SE		
4	Jandola	II-III		2.5	NE	FS	RT	NW		
5	Tank	II-III		23	NE	FS,Wa	PF	NW		Associated with Tangi anticline
6	Manzai			18						Associated with Manzai anticline
	a	II-III		8	NW	FS,Wa	PF	NE		
	b	II-III		3.5	NS	FS,Wa	PF	E		
	c	II-III		10	NE	FS,Wa	PF	SE		
	d	II-III		10	NE	FS,Wa	PF	NW		
7	Uttar	II-III		3	NNE	SO	St		R	
8	Pezu	I-II		12	NW	FS,Wa	PF	NE		
9	Paniala	II-III		7	NNW	FS	RT	E		
10	Paniala East	II-III		6	EW	FS,Ho,Gr	PF	E,W		Parallel traces

38N Shabqadar • 34-35° N by 71-72° E

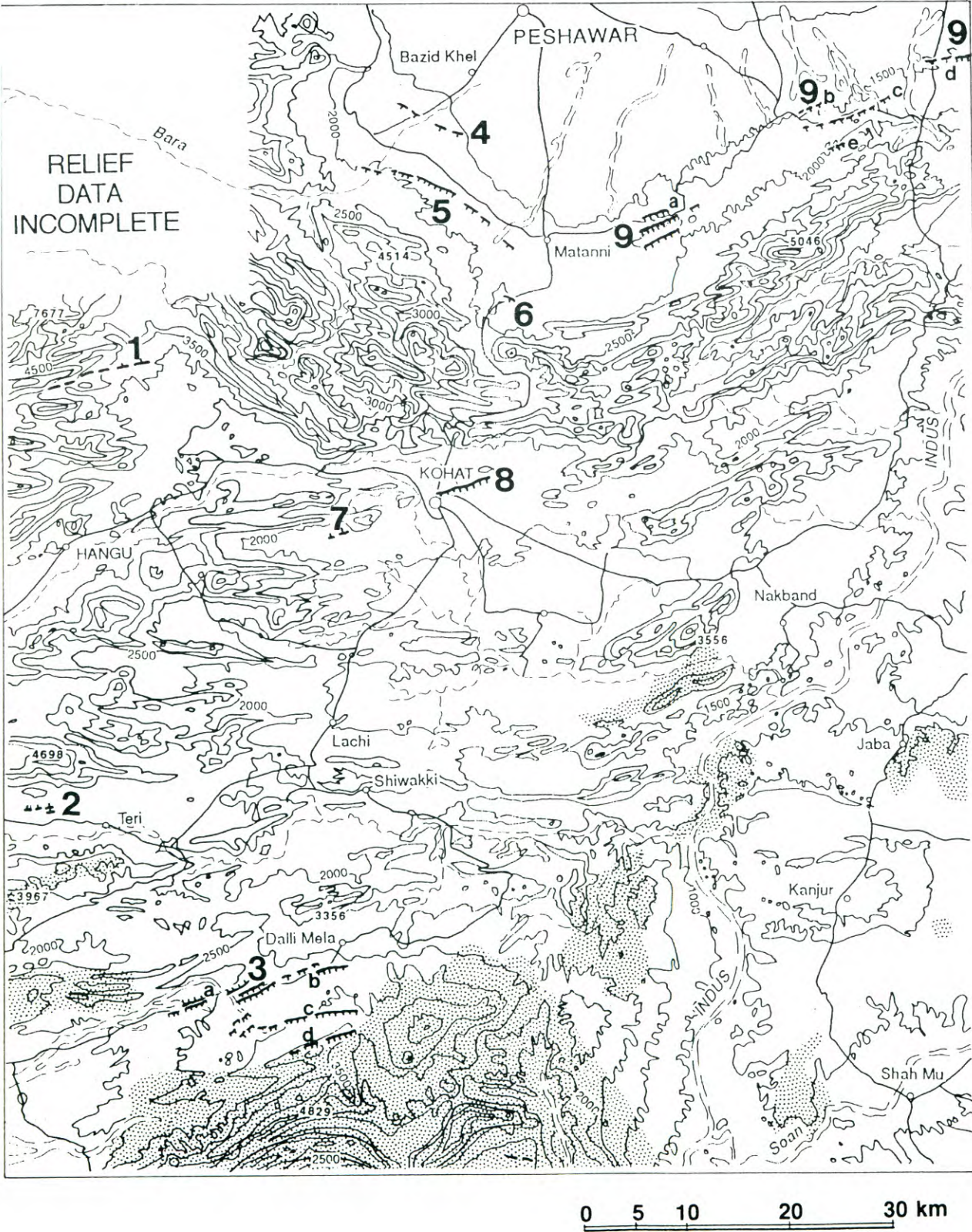


In this map-area, Lower Paleozoic to Precambrian rocks, which are a western extension of the Lesser Himalayas, surround the north-western margin of the Peshawar Basin. Lineaments with possible recent activity are located along the foot of the mountains north of the

Kabul River. They are short, intermittent, and uncertain features. The Main Mantle Thrust, which is the suture zone between the Indian Plate and the Kohistan Arc crosses the northern part of the map area, but no neotectonic features are found along it.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Kuchi			18						
	a	II-III		5	NNE	FS	PF	E		
	b	II-III		1	NS	FS,Sg	PF	E		
2	Rawal Koruna	II-III		1	NE	FS	PF	SE		

38O Kohat • 33-34° N by 71-72° E

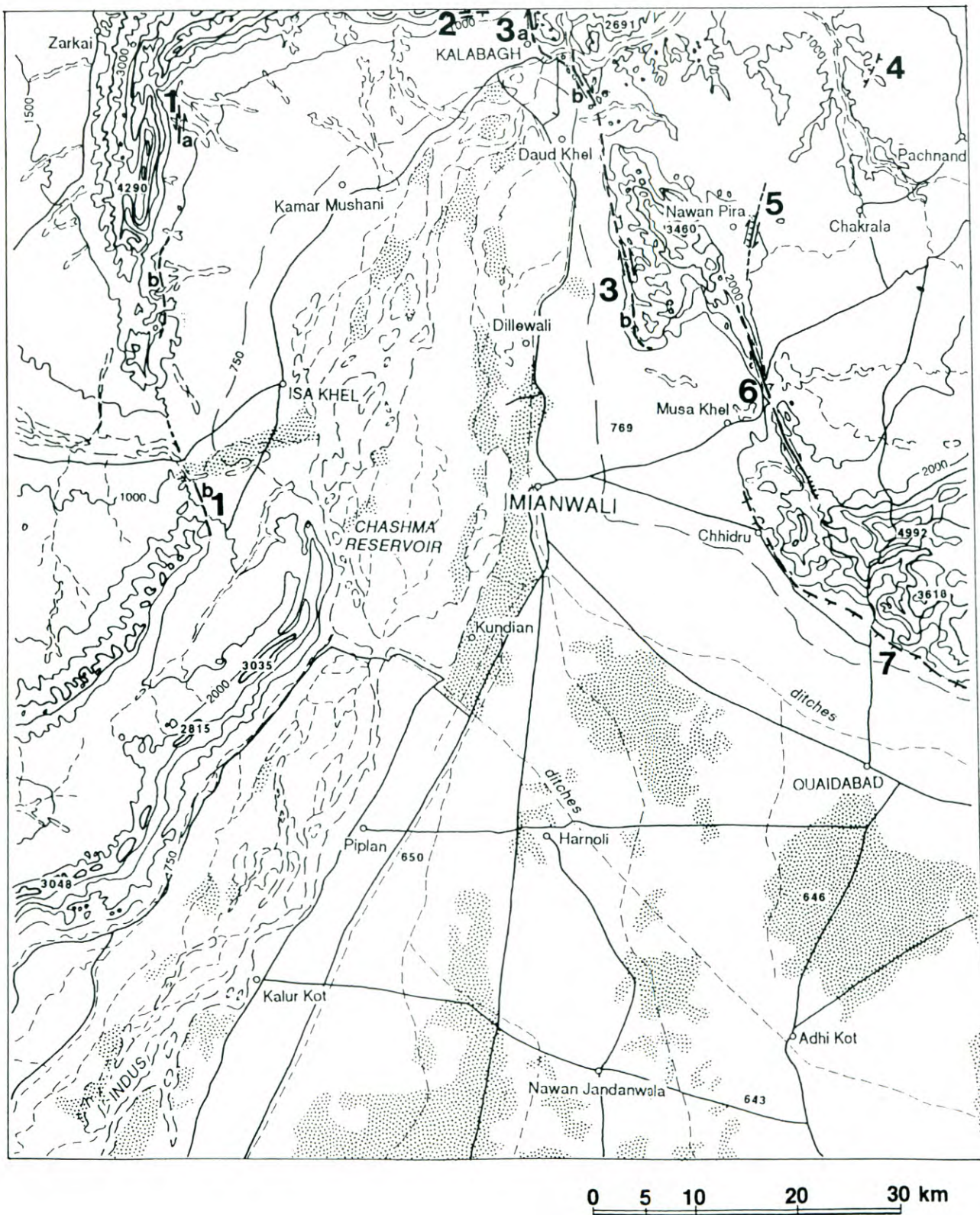


This map-area contains the Surghar Range on the south margin, part of the Kohat Plateau in the south half, the Hill Ranges in the north center, and the edge of the Peshawar Basin on the north margin. Active faults around the southern fringe of the Peshawar Basin are located along the boundary between the Hill Ranges and the Peshawar Basin. The 50 km long set of traces of the Manki Fault (9) extends along the southeastern fringe of the basin, and Pleistocene fan surfaces are consistently dislocated up to the north along them (Yeats and

Hussain, 1989). Generally, the Main Boundary Thrust shows no evidence of activity in Pakistan, but the Kohat Fault (8) seems to indicate reactivation of the thrust. The Kohat Fault vertically offsets river terraces up to the north. Northwest of Kalabagh, in the southern part of Kohat Plateau, many E-W trending faults are active. Among these faults, the Delli Mela Fault (3) is the most active, displaying distinctive fault scarplets on Pleistocene and Holocene fan surfaces.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Dauli	II-III		10	ENE	FS,Sg	PF,MS	S		
2	Teri	II	B	2.5	EW	FS	RT	S		
3	Delli Mela		B							
	a	I		10	EW	FS,Ho	PF,HF	N(PFl: 5), S		Parallel traces
	b	I		12	ENE	FS	PF,HF	N(PFm: 25, Pfl: 10)		
	c	I		3	NE	FS	PF	NW		
	d	I-II	B	11	ENE	FS	PF,HF,MS	N(PFh: 30, PFm: 10-15)		
4	Bara	II	C	7	NW	FS	PF	NE		
5	Khajuri	II		17	NW	FS	PF	NE		
6	Chabutra	II-III		1	WNW	FS	PF	N		
7	Sabi	II	B	1	ENE	FS	RT	S(RTl: 2)		
8	Kohat	I-II	B	5	ENE	FS	RT	N(RTm: 10, RTl: 5)		
9	Manki			(37)						43C(1), total 50km 3 parallel traces
	a	I		5	ENE	RS	PF	N		
	b	II		3	ENE	FS	MS	N		
	c	I-II	B	9	ENE	RS	MS	N		
	d	I		(4)	ENE	RS	PF	N		
	e	I-II		1.5	ENE	RS	PF	N		

38P Kundian • 32-33° N by 71-72° E



In this map-area, active faults are developed along the eastern fringe of the Surghar Range and the western margin of the Salt Range. Most of them extend NNW-SSE. In the former area, the youth of the fault traces is less certain. However, left-lateral strike-slip was definitely detected from stream offsets along the northernmost trace of the Surghar Range Front Fault (1). In the latter area, as reported by many former workers, right-lateral strike-

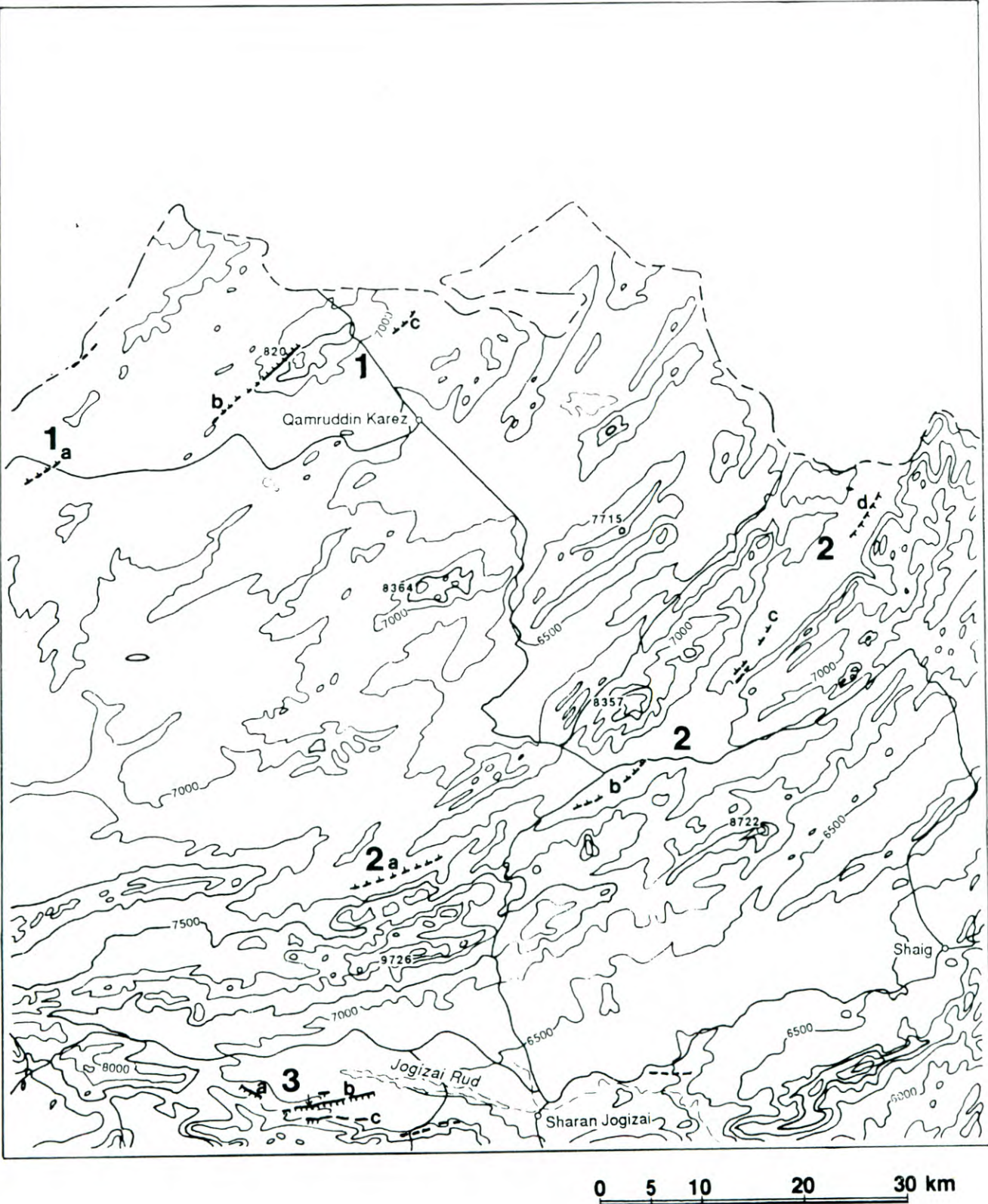
sip is clearly observed from stream offsets along the Kalabagh (3) (McDougall, 1990), Pira (5), and Musa Khel (6) Faults. The Salt Range Front Fault (7) does not display clear topographic evidence for its recent activity on air photos, although it is confirmed as active in the field by Quaternary sediments displaced over Holocene fan gravels (Yeats and others, 1984). As this is a low angle thrust fault, good air photo expression is not to be expected.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Surghar Range Front			40						
	a	II-III		4.5	NS	SO	St		L	
	b	III		30	NS	Li	MS			
2	Kalu Khel	II-III		2.5	EW	FS, Ho	PF	N,S		
3	Kalabagh			35						
	a	I-II		7	NNW	SO	St		R	
	b	II-III		30	NW	LV, Sg, SO	St, MS, V		R	
4	Pachnand	II-III		3	NNE	FS	PF	E, W		
5	Pira	II-III		8	NNE	FS	PF	E		
6	Musa Khel	I	B	20	NNW	SO, FS	St, MS	W	R(60)	
7	Salt Range Front	II		(35)	NW	Li	MF			



Figure 1. Landsat image of the Kalabagh (3) and Musa Khel (6) Faults along the west margin of the Potwar Plateau and Salt Range and the Surghar Range Front Fault (1). Landsat MSS 2691-04550-7.

39A Qamaruddin Karez • 31-32° N by 68-69° E



This map-area is of part of the Khojak Flysch Belt where fold axes tend to strike NE-SW and curve slightly convex to the southeast. Three active faults, which parallel fold axes, are reported. The Qamaruddin Karez Fault (1) has right-stepping fault traces along some segments on which Pleistocene and Holocene fan surfaces are vertically displaced. Recent activ-

ity is also shown by fault scarplets on Pleistocene fan surfaces along the Kundar (2) and Sharan Jogizai (3) Faults, which probably coincide with parts of the Kakar Khorasam Faults of Kazmi (1979b). The Sharan Jogizai Fault is a northern element of the Zhob Thrust System, which is also exposed in map area 39B to the south.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Qamaruddin Karez			42						Right-stepping en echelon
	a	II-III		3	NE	Li	PF			
	b	I	B	6	NE	FS	PF,HF	SE(1-5)		
	c	II-III		2.5	NE	FS	PF	SE		
2	Kundar		C	70						
	a	II-III		9	ENE	FS	PF	S		
	b	II-III		8	NE	FS	RT	SE,NW		
	c	II-III		8	NE	FS	RT	SE		
3	Sharan Jogizai		B	27						
	a	I	B	2	NW	FS	PF	NE		
	b	I	B	10	ENE	FS	PF,HF	N(PFI: 1-2)		
	c	I-II		7	EW	FS	PF	N(PFI: 1-2)		

39B Loralai • 30-31° N by 68-69° E

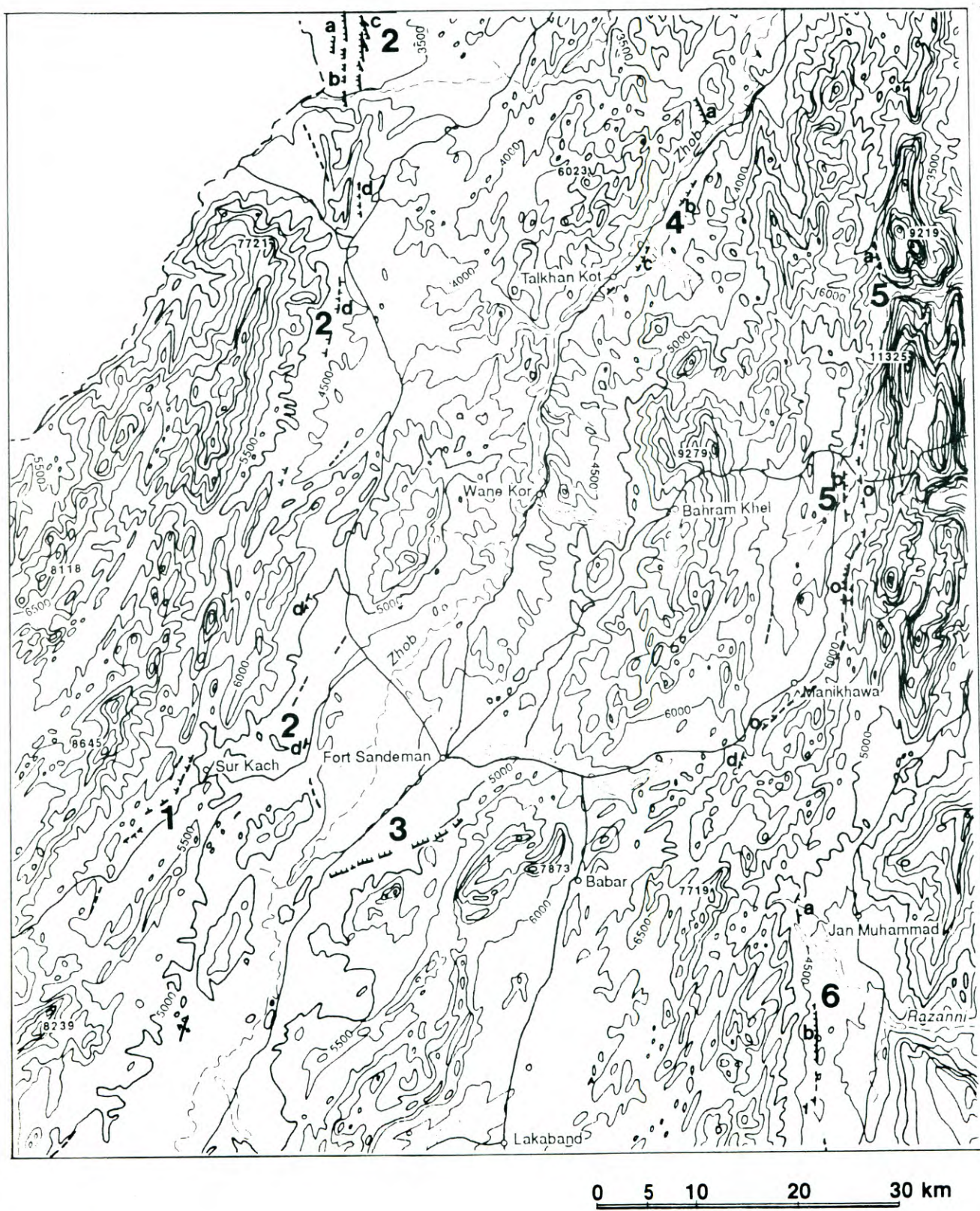


In this map-area several roughly E-W trending faults were found to be active with dip-slip motion. They are mostly bedding plane faults on the limbs of synclinal or anticlinal structures that are deforming by flexural-slip. Along the Zhob Thrust (Hunting Survey, 1960, Kazmi, 1979b) in the north, short intermittent active traces are present. The Nisai (1) and Dasht Murgha (3) Faults may also belong to the Zhob Fault System. The second of these is the more clearly active one. The Shinghar Fault (7), located along the fault of same name

first described by Kazmi (1979b), does not display distinctively active tectonic features along its trace and is placed in a low certainty class. Drazanda Fault (4) is the northernmost active structure in the Marginal Fold-and-Thrust Belt in this area. In the south, the Loralai Fault (6) displays clear evidence of Holocene activity. Fault scarplets and flexure scarps on Pleistocene fan surfaces along the Smallan (2) and Duki (5) Faults suggest that they also are quite active.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Nasai	II-III		7	EW	FS	PF	N		
2	Smallan	I	B	6	ENE	FS	PF	S(PFh: 15-20)		
3	Dasht Murgha									Cluster of bedding faults
	a	I		2	EW	FS	PF	S		
	b	I		2.5	EW	FS	PF	N		
	c	I		1	EW	FS	PT	N		
	d	I		1	EW	FS	PT	N		
4	Drazanda	I-II	C	1.8	EW	FS	PF	S		
5	Duki									Cluster of bedding faults
	a	I	B	2.5	EW	FS, Wa	PF	N(PFh: 1-2)		
	b	I		6	EW	Ti	PF	S		
6	Loralai			25						
	a	I	B	7	EW	FS, Gr	PF	S(PFm: 3-5), N(PFh: 17)		
	b	I	B	17	EW	FS	PF, HF	N(PFh: 1-2), S(PFm: 3-5)		
7	Shinghar	II-III	B	11	NE	FS	PF	NW		
8	Mara Kili	I	C	8	NE	FS	PF	NW(PFh: 2-5)		
9	Wahar	I		9	NE	FS	PF	NW(PFh: 5-7)		

39E Fort Sandeman • 31-32° N by 69-70° E



Many short intermittent active fault traces are roughly aligned along two N-S trending geologically mapped fault zones in this area. Both have active segments. It is, however, difficult to confidently relate the locations of the active traces found by the present authors to those described by previous workers, as their small scale maps inherently give ambiguous locations. The first zone is along the poorly known Waziristan Fault between the Khojak flysch belt and the Marginal Fold Belt (DeJong, 1982). This northern extension of the Zhob Thrust Fault is related to the ophiolite zone. Active traces of the Tumankai Fault (2) are located along the Zhob Thrust, and they appear

to show dip-slip displacement. However, the northernmost part of these faults consists of parallel fault traces each of which is arranged in a right-stepped en echelon pattern (2c). This may imply a component of left-lateral strike-slip along the traces but we have found no confirming topographic evidence so far. Most of the southern segments of the fault have obscure fault scarplets on Pleistocene fan surfaces that provide less confident evidence (2d). The second zone is the Sulaiman Range Fault Zone along the western side of the topographically high Sulaiman Frontal Fold Belt. This high region is underlain by a major thrust culmination (Humayon and others, 1991). The Mani-

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Sur Kach	II		12	NE	FS	PF	E,W		
2	Tumankai		B	(72)						38H(1), total 82km
	a	I-II		1.5	NS	FS	PF	E		
	b	I		8	NS	FS	PF	E		
	c	I		7	NS	FS,Sg	PF	E		
	d	II-III		60	NS	FS,Li	PF,RT	E,W		Series of short, intermittent traces
3	Fort Sandeman	I	C	14	ENE	FS	PF	S(PFm: 5)		
4	Talkhan Kot			22						
	a	I		2	NNW	FS	PF	E		
	b	II-III		2.2	NE	FS	PF	SE		
	c	II-III		1.5	NE	FS	PF	SE		
5	Manikhawa									
	a	II		3	NNW	FS,LV	PF,V	E		
	b	II		3.5	NS	FS	PF	W		
	c	I-II		34	NNE	FS,Li	PF,MS	E(PFI: 5-7, PFm-h: 10-15)		
	d	II-III		2	NNE	FS	PF	NW		
6	Jan Muhammad			23						
	a	II-III		3	NS	FS	PF	W		
	b	I	B	12	NS	FS	PF	E(PFm: 10,PFI:3)		

39E Fort Sandeman

khawa (5) and Jan Muhammad (6) Faults cut fan surfaces and record active deformation between the interior of the Sulaiman Lobe and the eastward thrusting culmination. Two active faults, the Fort Sandeman (3) and Talkhan

Kot (4) Faults are found within the Sulaiman Lobe. The Talkhan Kot Fault has dip-slip active traces, although both Abdel-Gawad (1971) and Kazmi (1979b) ascribed recent left-lateral displacement to it.

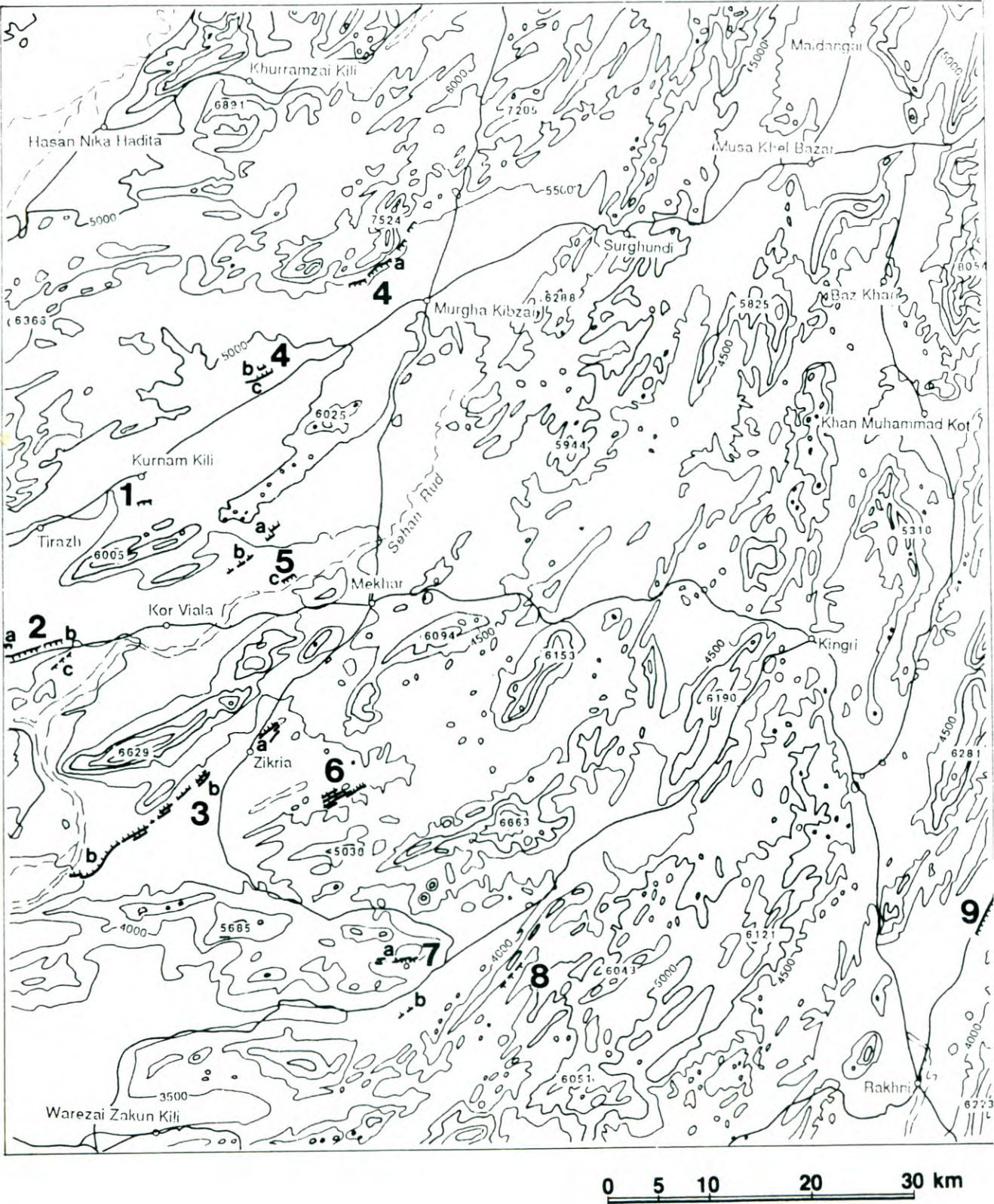


Figure 1. Landsat image of the Fort Sandeman (Map sheet 39E). The Sur Kach (1) and Tumankai (2) Faults west of Fort Sandeman occur near the west edge of the image. Landsat MSS 2692-05010-7.



Figure 2. Landsat image of the Musa Khel Bazar area (Map sheet 39F). Numerous short active faults are present. Most appear to be related to flexural-slip fold processes. Distance between cross marks is 10 km. Landsat RBV 30247-05150-A.

39F Musa Khel Bazar • 30-31° N by 69-70° E

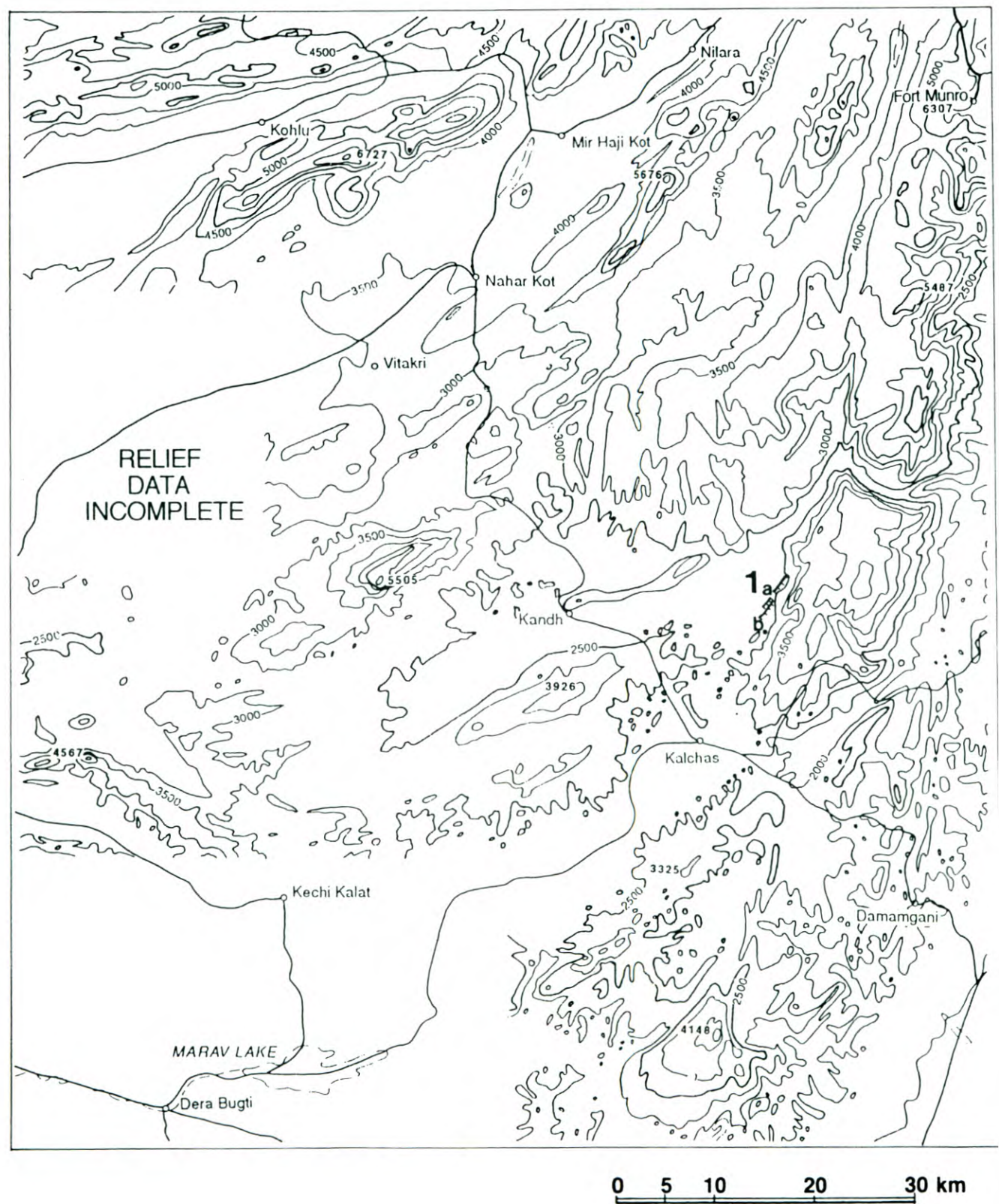


There are many distinctive short, dip-slip active faults in this part of the Sulaiman Fold Belt. They are mostly bedding-parallel faults closely related to active flexural-slip folding. A typical example of this kind of faulting is the Zikria Fault (3), which appears on the south-western limb of small anticline in Loralai Limestone. Pleistocene and Holocene fluvial surfaces have been cumulatively displaced along such bedding-parallel faults. The left-lateral

strike-slip Kingri Fault extends NNW-SSE in the east central part of the map-area, passing just west of Kingri town. Although previous workers refer to it as an active fault (Rowlands, 1978), no topographical evidence indicates that such activity has occurred on it during the late Quaternary. Kharlak Fault (9) is the only active fault in the eastern part of the area. For a Landsat image see page 119.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Kurnam Kili	I		1.5	ENE	FS	PF,HF	N		
2	Kotkai			7						
	a	I		2	EW	FS	PF	N(PFh: 5)		
	b	I		7	ENE	FS	PF	N(PFh: 2-7)		
	c	II		2	NE	FS	PF	NW		
3	Zikria			27						Associated with active folding
	a	I	B	2.5	NE	FS,Li	PF	SE(PFm: 1-5)		
	b	I	B	17	NE	FS	PF	SE(PFI: 2-3, PFm: 5-7)		
4	Murgha Kibzai			23						
	a	I	B	8	NE	FS	PF,HF	NW(PFm:5-10, PFI: 2-3)		
	b	I	C	1	ENE	FS	PF	S(PFm-h: 2-3)		
	c	I	C	1.5	ENE	FS	PF	S(PFm-h: 2-3)		
5	Mekhar									
	a	I-II		2	NE	FS	PF	SE		
	b	II	B	3.5	NE	FS	PF	SE(PFI: 2-3)		
	c	I		1	NE	FS	PF	NW(PFm: 2-5)		
6	Zikria South	II		4	ENE	FS	PF	S		Cluster of bedding faults
7	Malezai									
	a	I		4	EW	FS,Li	PF	S(PFm: 10), N(PFm: 10)		
	b	II		1.5	NE	FS	PF	SE(PFI: 2-3)		
8	Chamalang	II-III		3.5	EW	FS	PF	NW		
9	Kharlak	I-II	C	(3)	NE	FS	PF	NW(3-10)		39J(1), total 6km

39G Fort Munro • 29-30° N by 69-70° E



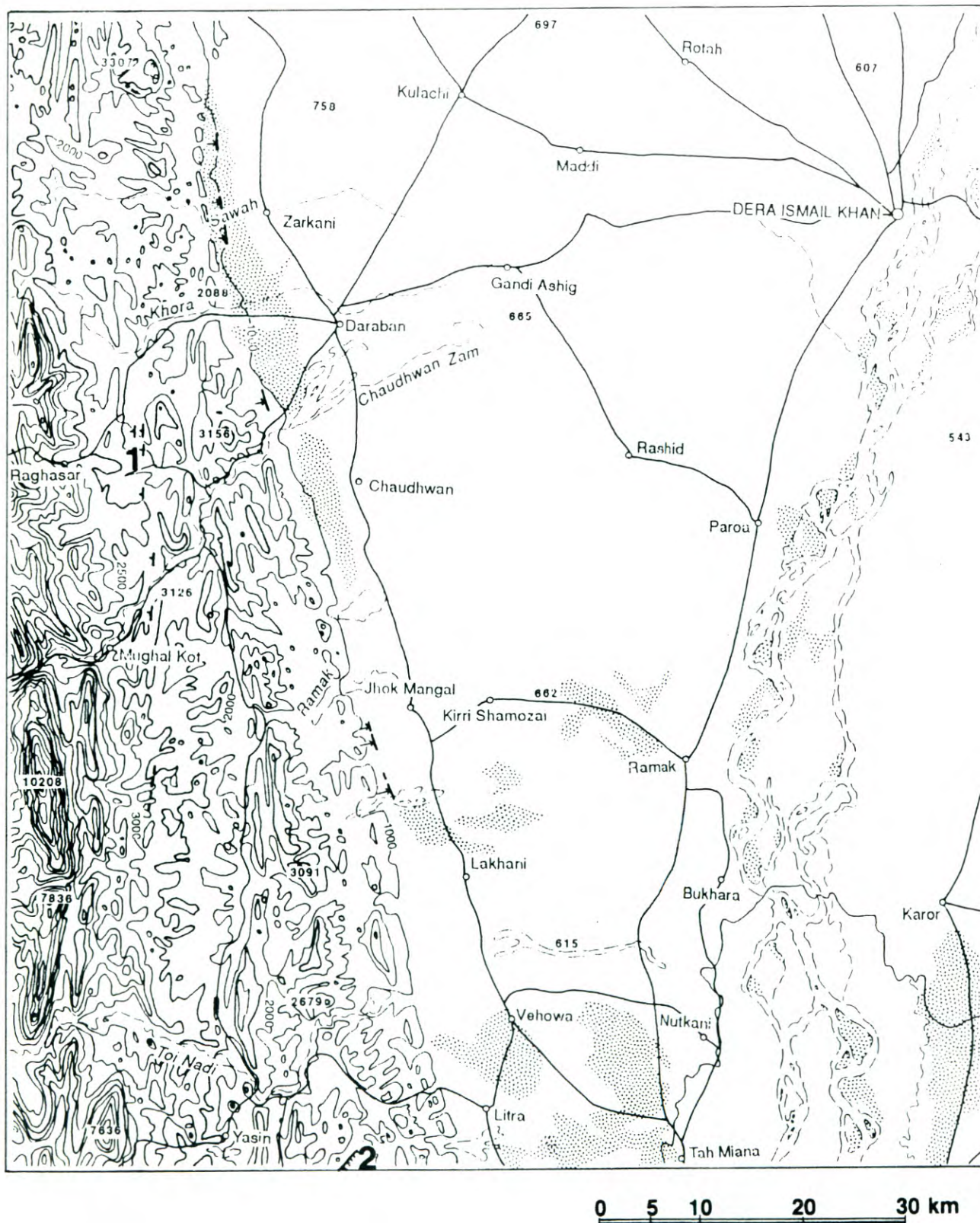
In this map-area, only Nila Kund Fault (1) is found to be active. It consists of two parallel short segments that have displaced Pleistocene fan surfaces up to the west. No active faults

are recognized in the southern part of Sulai-man Lobe (map-area 39H), although seismic activity is quite high in shallow part of the crust there (Quittmeyer and others, 1979).

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Nila Kund		C	6						
	a	I		5	NE	FS	PF	NW(1-5)		
	b	I		3	NE	FS	PF	NW		



Figure 1. Landsat image of the Fort Munro area. Distance between cross marks is 10 km. Landsat RBV 30247-05150-D.



Both Abdel-Gawad (1971) and Kazmi (1979b) claimed that there were Recent left-lateral wrench faults along the eastern and western margins of Sulaiman Range. However, we recognize only N-S dip-slip fault scarplets along its western margin (see map sheet 39E) and eastward tilting of Pleistocene fan surfaces along its eastern margin. These tilted fans are recorded by the unnumbered arrow and line

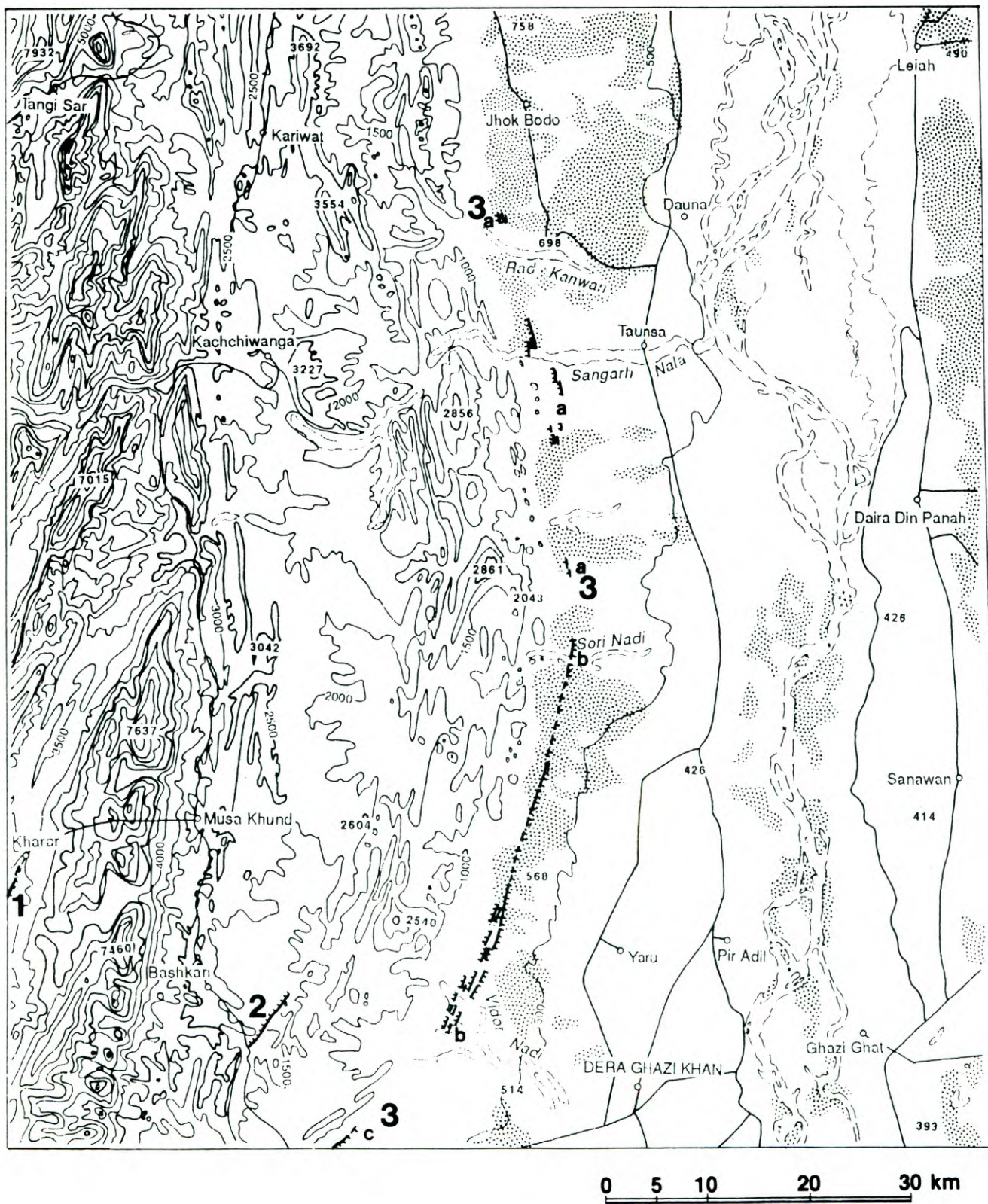
symbols which show the tilt orientation. No surface fault is present, and the tilting probably occurs over a blind thrust (Humayon and others, 1991). This may indicate that only dip-slip faulting has been taking place along these margins. Litra Fault (2) is a NW-SE striking active fault that displaces river terraces up to the northwest.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Raghasar	II-III		19	NS	FS	RT,PF	E		Intermittent traces
2	Litra	I-II		2.5	NE	FS	PT	NW		



Figure 1. Landsat image of the Dera Ismail Khan area. Tilted Quaternary sediments can be seen along the Sulaiman Range Front. Active folds in map area 38L are seen in the north of the image. Landsat MSS 2692-05010-7.

39J Dera Ghazi Khan • 30-31° N by 70-71° E



The eastern margin of Sulaiman Range is most active in this map-area, although active faults have not been previously reported here. The Chandwan Fault, a proposed active structure terminating in the northern part of this area by Kazmi (1979a, b) was not found, but active faulting is quite prominent farther south. The Sulaiman Range Front Fault (3) is marked

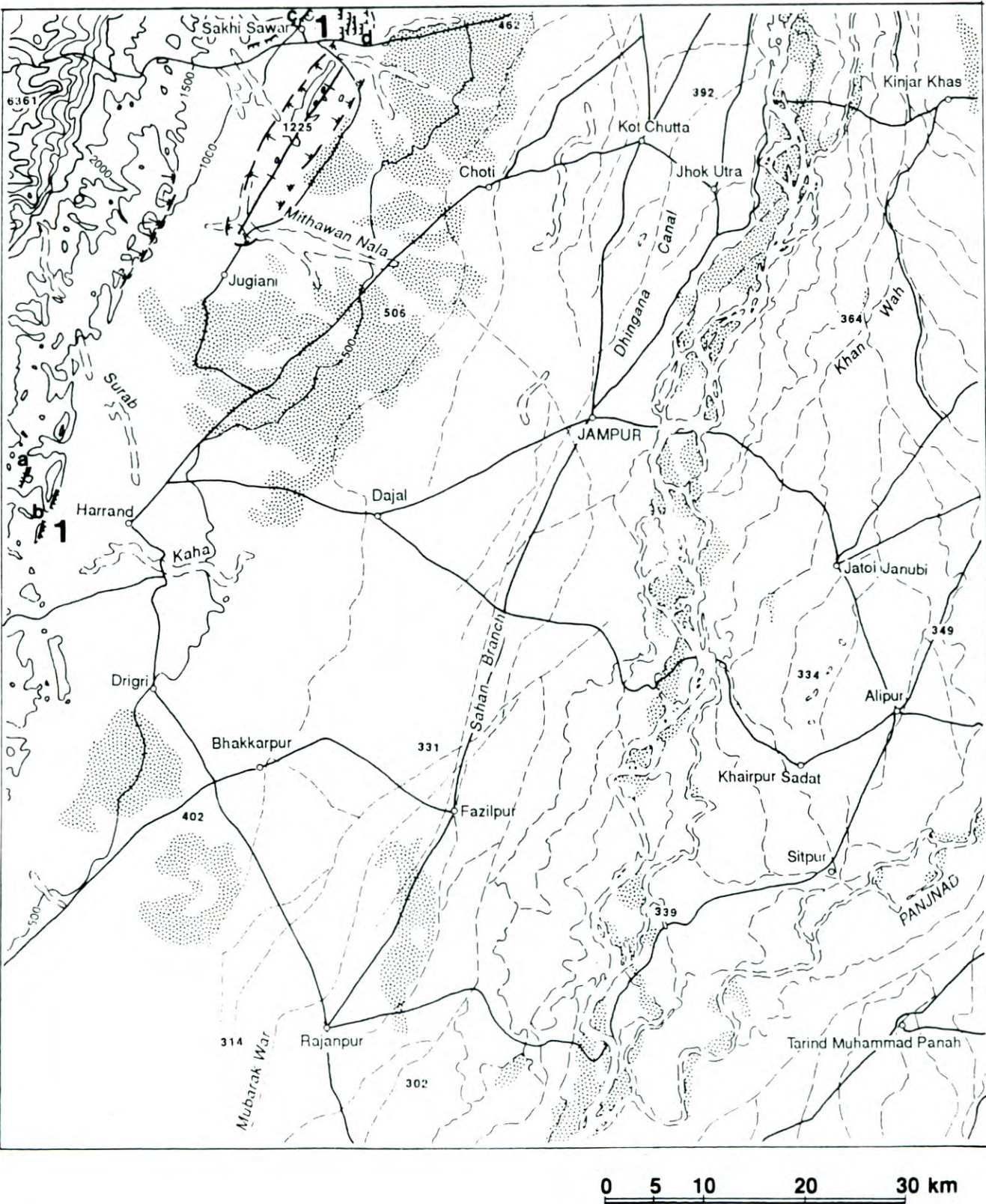
by a well-defined series of roughly N-S trending and mostly west-facing fault scarplets. These are formed by closely spaced, short, bedding-parallel faults that are associated with active flexural-slip folding. They overlie the tip line of fault propagation folds in a blind thrust system (Humayon and others, 1991).

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ.	Remarks
1	Kharlak	I	B	(3)	NNE	FS	PF	W		39F(9), total 6km
2	Bashkan	I	B	6	NE	FS	PF	SE(PFh: 20, PFm: 5-10)		
3	Sulaiman Range Front		B	(100)						39K(1), total 160km
	a	I-II	B	37	NNW	FSRS, Wa,Ti	PF	E(10), W		Bedding faults associated with folding
	b	I-II	B	40	NNE	FS,RS, Ti,Ho	PF	W(PFf-m: 2-5, PFm: 20), E(PFh: 20, PFhh: 30)		
	c	I		3	NE	FS	PT	NW(50)		



Figure 1. Landsat image of the eastern margin of the Sulaiman Range in the Dera Ghazi Khan area. The Kingri Fault is present on the west side of the image (Map sheet 39F). Distance between cross marks is 10 km. Landsat RBV 30247-05150-B.

39K Rajanpur • 29-30° N by 70-71° E



The Sulaiman Range Front Fault (1) is quite active in the northwestern part of this map-area. It is represented by NE-SW extending fault scarplets and eastward tilting on Pleistocene fan surfaces. A young anticlinal ridge is still growing in the plain, and to the north of it short bedding faults associated with

folding are distinctive on Pleistocene terraces. Humayon and others (1991) have shown that the eastern margin overlies an eastward directed blind thrust, and this is recorded along the eastern fringe by the consistent eastward tilting.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ.	Remarks
1	Sulaiman Range Front		(60)							39J(3), total 160km
	a	I		1.5	NNE	FS	PF	E		
	b	I		6	NNE	FS,Ti	PF,MF	W		
	c	I		(6)	NE	FS	PF	NW(15-20)		
	d	I		3	NS	FS	PT	E(5-10), W		Cluster of bedding faults

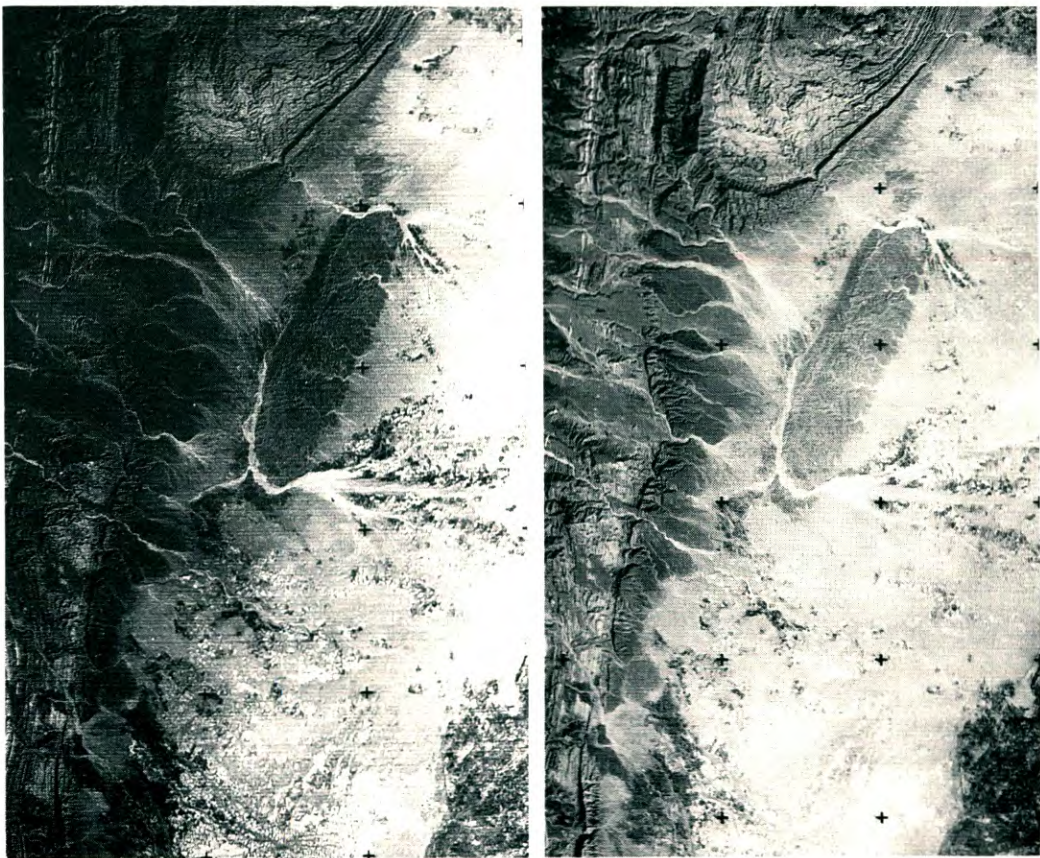


Figure 1. Stereo pair of Landsat images of the southern end of Zinda Pir and Sakhi Sarwar Anticlines. Sakhi Sarwar is the small fold east of the Sulaiman Range Front. Distance between cross marks is 10 km. Left Landsat RBV 30247-05150-D and right Landsat RBV 30246-05091-C.

43B Mardan • 34-35° N by 72-73° E



How active the faults found in this map-area are is relatively uncertain, except for part of the Nowshera Fault (2). The Nowshera Fault first described by Kazmi (1979b). It displaces Pleistocene fan surfaces and mountain slopes. Although Kazmi inferred right-lateral strike-slip along the fault, there is no evidence for such activity along the traces found. On the west bank of Tarbela Reservoir, active faults extend N-S along a part of the Tarbela Fault Zone of Kazmi (1979b). Seeber and others (1980) report seismic activity along this zone, which they call the Indus Fault Zone, and con-

firm ground expression for the structure. Consistent left-lateral stream diversions are observed along their traces. Pennington (1979) discussed the Pattan Earthquake of 1974, which had an epicenter in the northeast corner of this area, but produced no ground rupture. This suggests that most tectonic activity in the north is concentrated on deep detachment planes. North of this map-area, active faults are rare. The only possible examples are some short, possibly active lineaments that were located on a mountain slope in the southern margin of map-area 42D.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Wuch	III		5	NE	Li	MS			
2	Nowshera	I-II		5.5	ENE	FS	PF,MS	N		
3	Tarbela	II-III		6.5	NNE	SO	St		L	

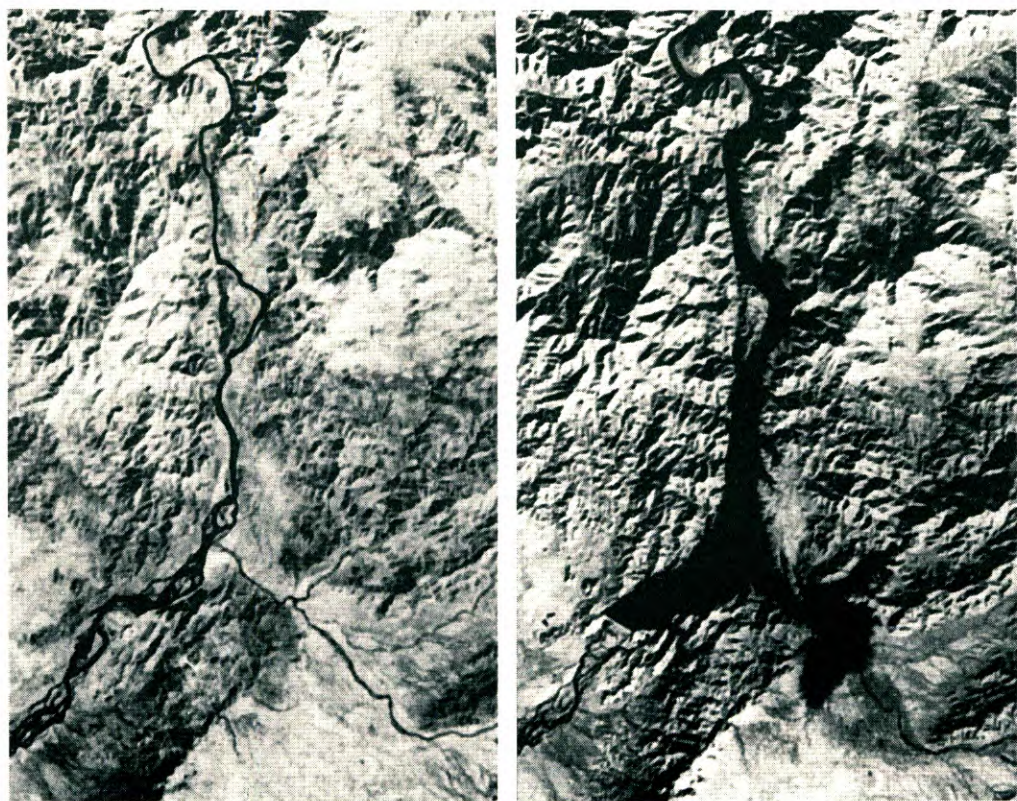
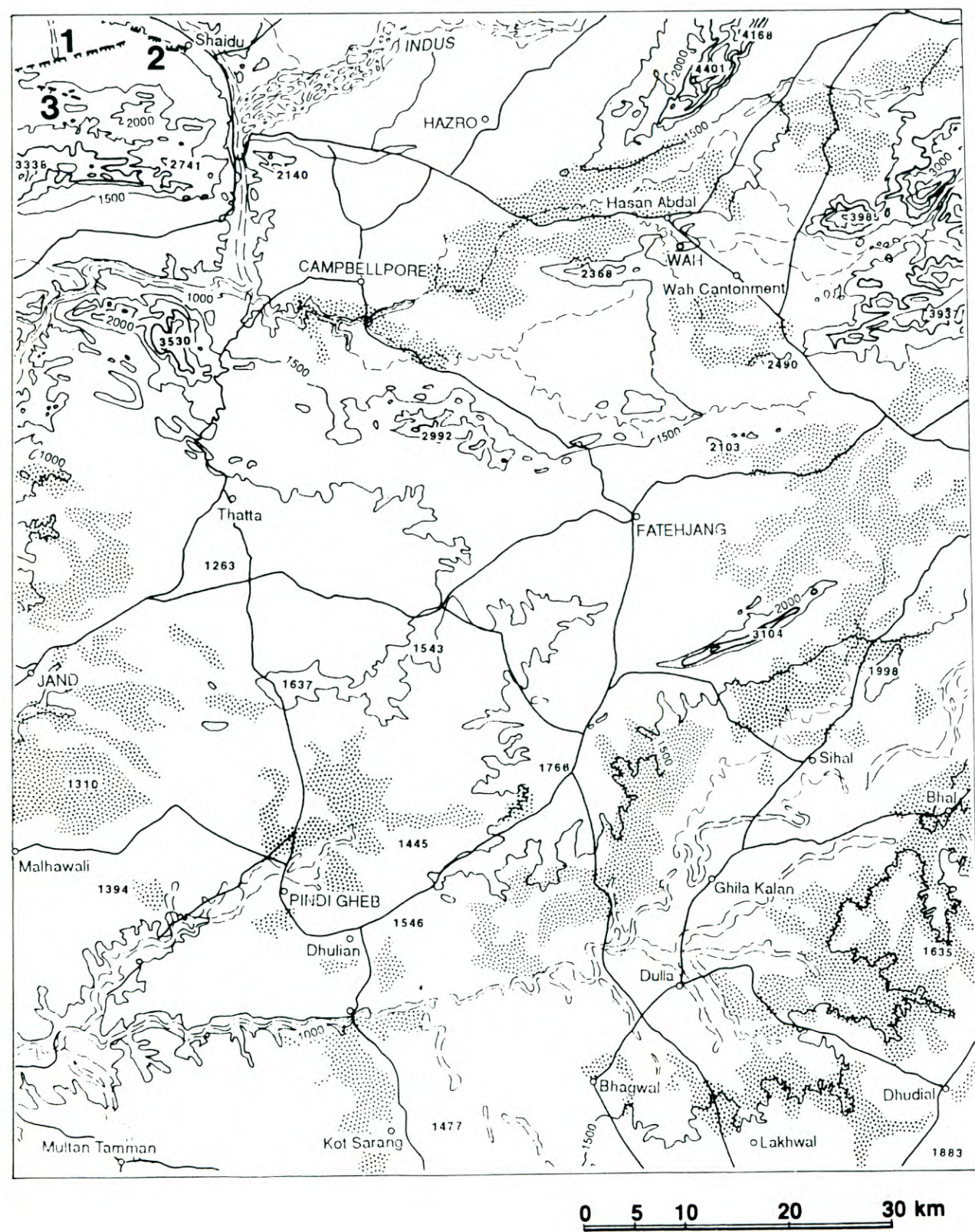


Figure 1. Stereo pair of Landsat imagery of the Indus River in the Tarbela Reservoir area. Left Landsat MSS image ID unknown and right Landsat MSS 2672-04494-7.

43C Campbellpur • 33-34° N by 72-73° E



Part of the Manki Fault (Yeats and Hussain, 1989) is located in the northwestern corner of this map-area. Traces of this fault may be on the western part of Kund Fault of Kazmi (1979b). Along ENE-WSW trending active traces, Pleistocene and Holocene fan surfaces are increasingly displaced up to the north (Yeats and Hussain, 1989). West of Shaidu

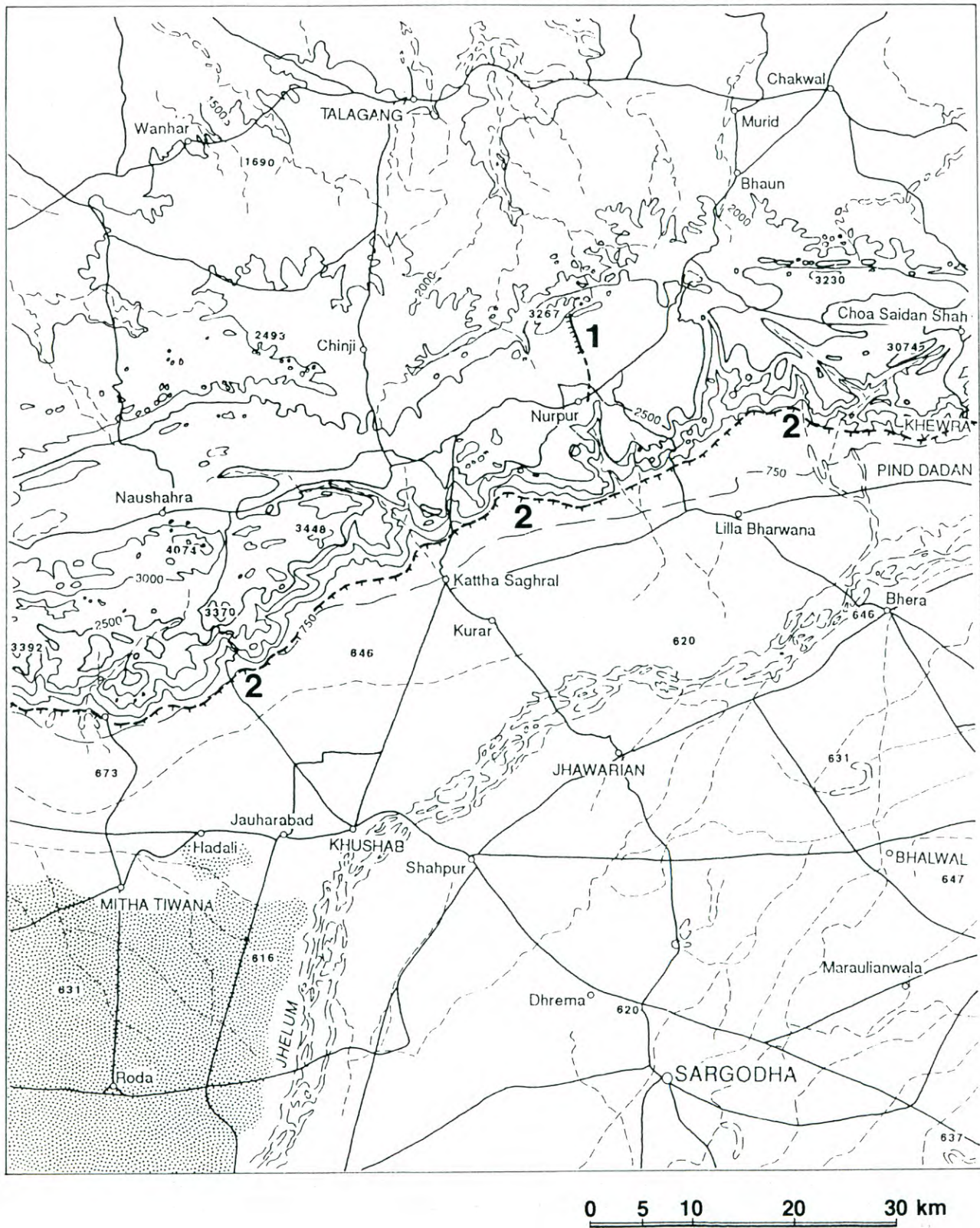
town, the Shaidu Fault (2) forms a series of well aligned, NW-SE trending, active traces along which Pleistocene fan surfaces were dislocated. A small graben was formed between subparallel traces on the southeastern end of the fault. No other active faults were found in this map-area.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ.	Remarks
1	Manki	I	B	(10.5)	ENE	FS	PF,HF	N		38O(9), total 50km
2	Shaidu	I		7	NM	FS,Gr	PF	SW,NE		Right-stepping fault traces
3	Ziarat Kaka Sahib	II-III		4	EW	FS,Li	PF	N		



Figure 1. Landsat image of the northern Potwar Plateau, Kala Chitta Hills, and Attock Hills. The Manki (1), Shaidu, and Ziarat Kaka Sahaib Faults are in the northwest corner of the image. Landsat MSS 2691-04550-7.

43D Sargodha • 32-33° N by 72-73° E



This map-area contains the southern margin of the Salt Range. Along its foot convincing geological evidence for recent thrust motion was found by Yeats and others (1984). However, tectonic features reflecting this activity such as young fault scarps or tilted geo-

morphic surfaces were not found by photo-interpretation. An N-S trending fault is found to be active near Nurpur. The rest of the map-area is without recognized active tectonic features.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Nurpur	I-II	C	14	NNW	FS	PT	E		
2	Salt Range Front	II		(110)	ENE	FS	MS	N		

43F Abbottabad • 34-35° N by 73-74° E



In this map-area, active faults are concentrated around the sharp bend of the Jhelum River at Muzaffarabad. On the north side of the river at Muzaffarabad, Quaternary terraces are tilted at least 15° to the east. On the right bank of the river southeast of Tanda, Pleistocene fan surfaces along the foot of an anticlinal ridge are vertically dislocated by a NW-SE

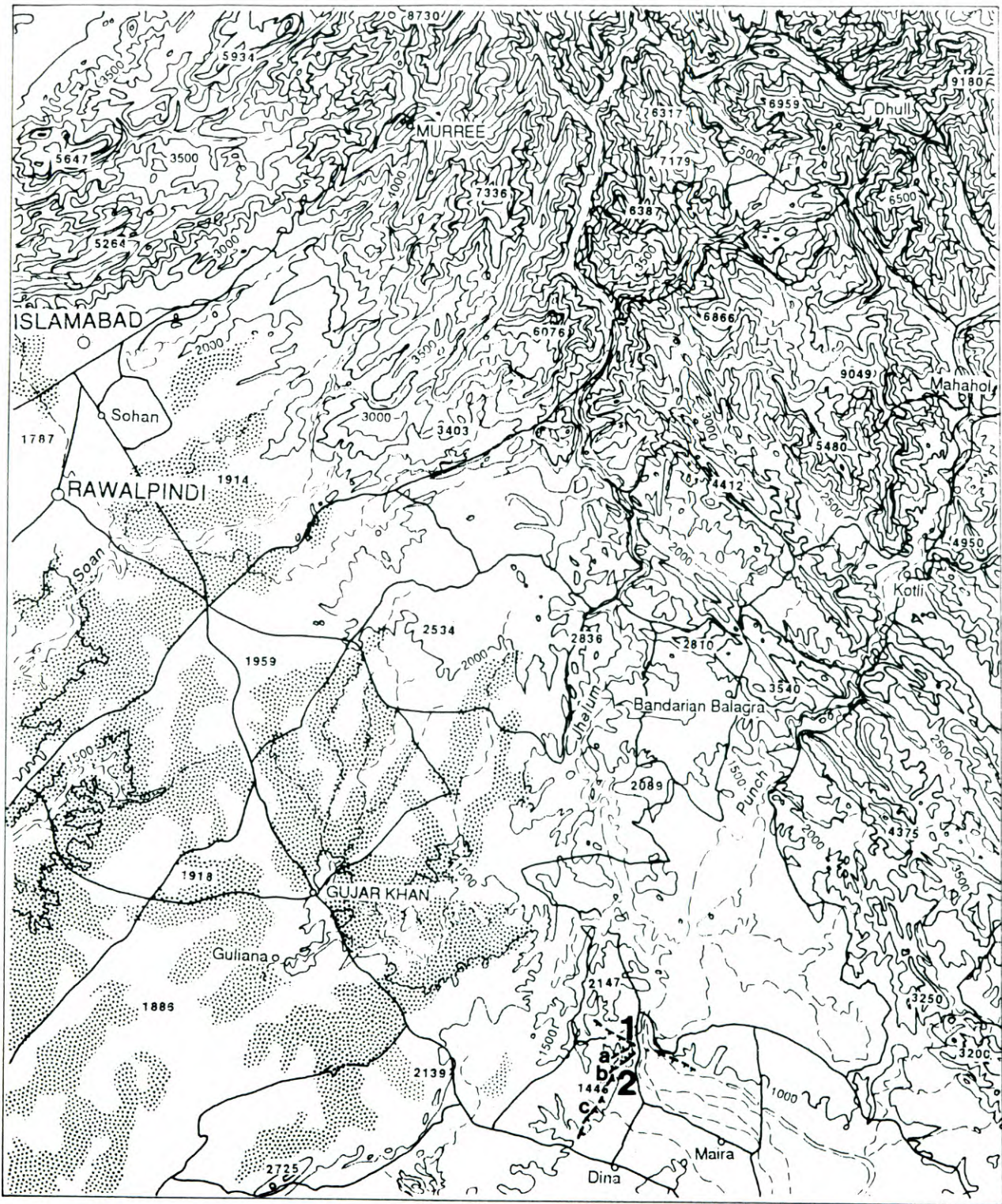
striking fault. West of Muzaffarabad, another active fault extends N-S for 10 km. Along this fault, terraces of the Jhelum River and its tributaries are vertically dislocated to form clearly reverse-displaced scarplets and fault sags. No lateral displacements along these faults have been confirmed during this study.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Muzaffarabad	I-II		8	NS	RS,Sg,Li	PT	W		
2	Tanda	I-II	B	16	NW	FS	PF	NE		



Figure 1. Landsat image of the Abbottabad area. Active faults are found near Muzaffarabad. Landsat RBV 30569-05000-C.

43G Rawalpindi • 33-34° N by 73-74° E



In this map-area, active faults are located in a quite limited region between the hilly terrain around the Jhelum River mouth and the plain north of Maira. They are WNW-ESE or ENE-WSW trending faults. One might expect to find lateral-slip along them, but only dip-

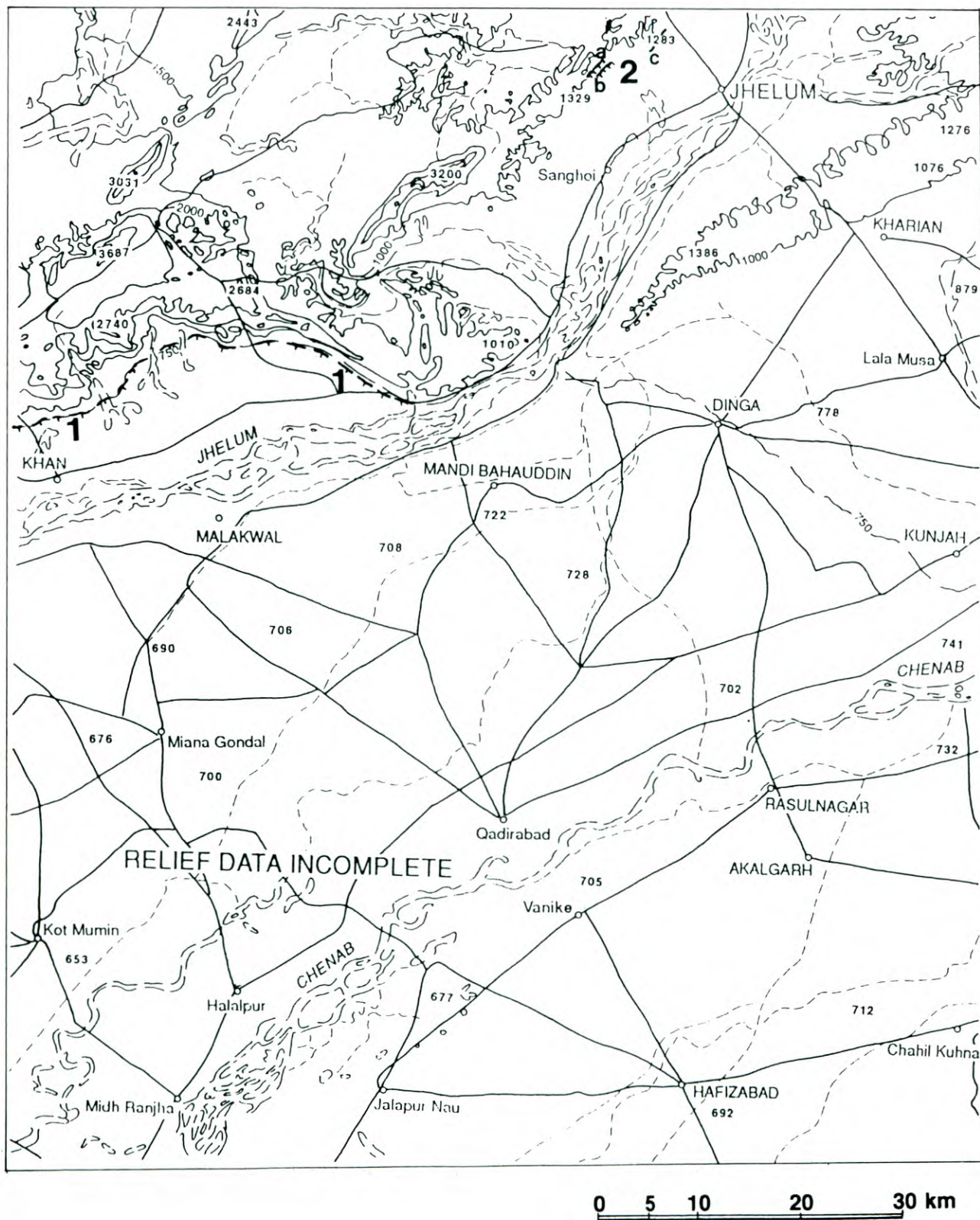
slip is recorded by tectonic features along their active traces. Maira Fault (2) is a class I fault along which Pleistocene river terraces were displaced up to the south and reverse scarplets were formed.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Mangla	II-III		11	NW	FS	PT,HT	NE(5-10)		
2	Maira			10						
	a	II		1	ENE	RS	PT	S		
	b	I	B	2.5	NE	RS	PT	SE(10)		
	c	II-III	B	6.5	NNE	FS	PF	W(30)		



Figure 1. Landsat image of the Islamabad/Rawalpindi area. The Mangla (1) and Maira (2) Faults are now concealed under Mangla Reservoir. Landsat MSS 2294-04594-7.

43H Jhelum • 32-33° N by 73-74° E



Along eastern margin of the Salt Range, northwest of Jhelum city, short intermittent active fault traces of the Jhelum Fault (2) trend NE-SW. They dislocate Pleistocene river ter-

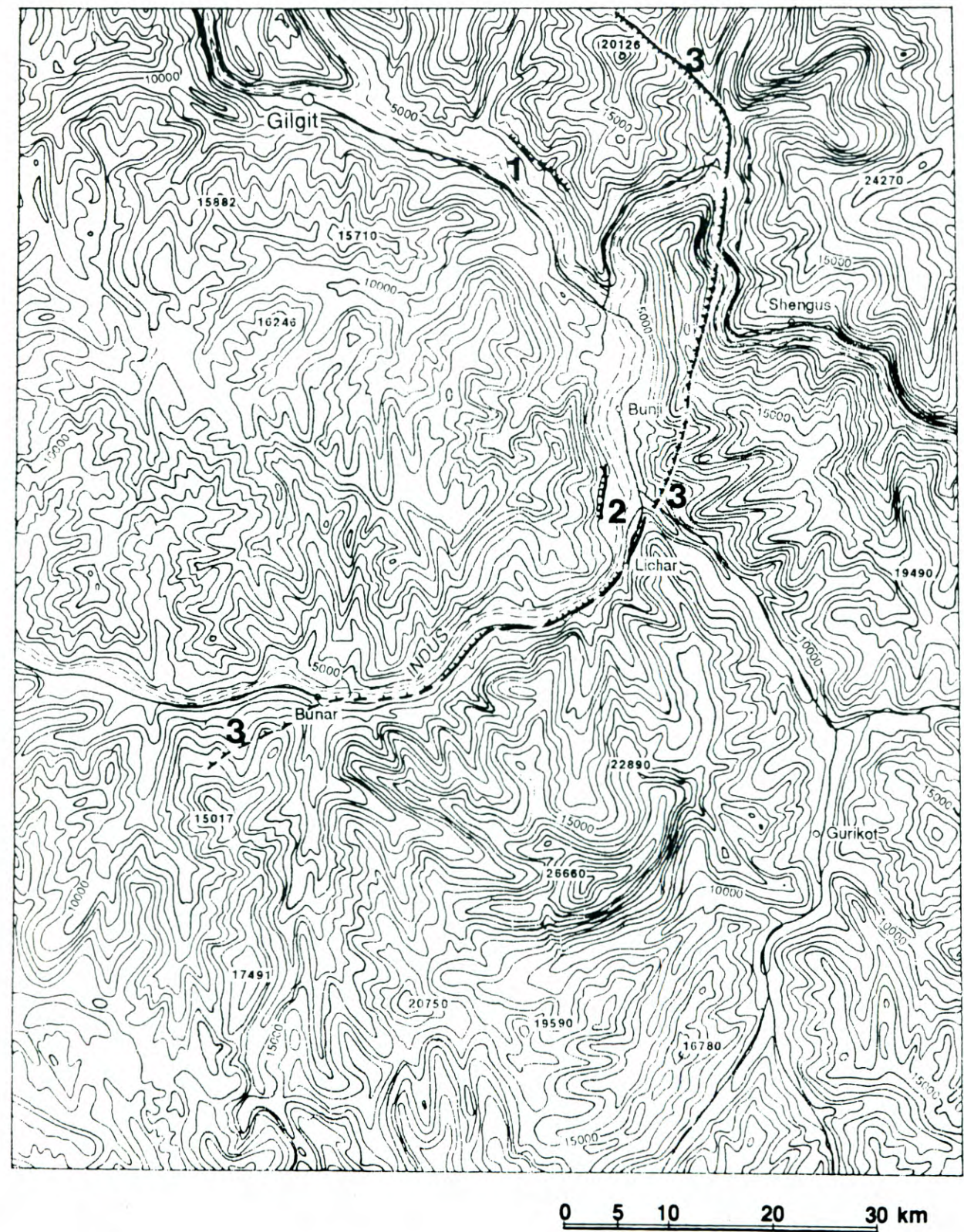
aces and fan surfaces forming distinctive fault scarplets. They may lie on the extension of the Salt Range Front Fault (1). No active faults were found in the rest of this map-area.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Salt Range Front	II		(40)	EW	FS	MS			
2	Jhelum			10						
	a	I		2.5	NE	FS	RT	NW		
	b	I		2.5	NE	FS	RT	NW		
	c	II		2	NE	Li	PF			



Figure 1. Landsat image of the eastern Salt Range Front. This is an active fault, but as a low angle thrust fault it creates few features which confirm that it is active on imagery. The distance between the cross marks is 10 km. Landsat RBV 31433-05025-C.

43I Gilgit • 35-36° N by 74-75° E



The Main Mantle Thrust Zone is the suture between the Marginal Fold-and-Thrust Belt to the south and the Kohistan Volcanic Belt to the north. Raikot Fault (3) offsets the trace of MMT on the right bank of Indus, dislocating fluvioglacial sediments along oblique thrust planes (Lawrence and Ghauri, 1983, Lawrence and Shroder, 1984, Madin and others, 1989, Shroder and others, 1989). Near Raikot, the fault offsets talus cones. The trace of the fault is commonly the location of hot springs. It is, however, hard to find traces of it on aerial photographs. No lateral displace-

ment has been detected on these features. Aerial photographs of the mountainous north contain major inherent distortion due to the extreme relief. Therefore, this kind of reconnaissance study is less rewarding in such places. The Chhamongarn (1) and Thelichi (2) Faults are topographically well-defined with fault scarplets on mountain slopes and Holocene fan surfaces. These are good indicators of recent activity on them. The expression of the Thelichi Fault is complicated by a line of aeolian sand coincident with the fault trace.

#	Fault Name	Class	Act	Len Km	Strike	Fault Features	Fault Reference	Vertical Displ. (m)	Lateral Displ. (m)	Remarks
1	Chhamongarn	I	B	7.5	NW	FS	MS	SW		
2	Thelichi	I	B	5	NS	FS	MS,HF	E		
3	Raikot	I-II		105	NS	FS	MS,FgT	E		



Figure1. Looking south along the Indus River from near its most northern point on the bend northwest of Shengus. The Raikot Fault (3) displaces glacial sediments on the east side (left) of the valley above the town of Sassi.

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受領書

1. 品名 『*Active Faults of Pakistan*』

2. 数量 部

上記のとおり受領致しました。

平成 年 月 日

受領機関名

印

広島大学総合地誌研究資料センター 殿