THE STRUCTURE OF QUETTA VALLEY

Dr. S. H. A. Shah,
Director, Geological Survey of Pakistan, Quetta.

ABSTRACT

The structure of Quetta Valley in general came out to be not as intricate as it was supposed to be due to its proximity to Sibi wedge. The Chiltan, Murdar Ghar and Takatu are the major anticlinal folds of the area intervened by the Quetta synclinorium. However, the detail of the structure with clements of folds, faults, culminations and depression demands an explanation for their origin and a typical mode of occurrence in the area which has been provided in the paper.

INTRODUCTION

Location and Topography of the area.

The geological structure of the Quetta Valley had not so far been discerned satisfactorily. Since the establishment of the headquarters of Geological Survey of Pakistan in Quetta in 1947, the geologists always longed for its study and detailed explanation. The author has made a thorough study of complex and complicated structural features in the field and tried to explain the structure of the Quetta valley in detail in this paper.

Quetta is a well known city of Pakistan. It is the capital of Baluchistan province. One enters the Quetta valley from Sind after passing through the famous Bolan Pass. The town of Quetta is 5,500 feet above the sea level and attract a number of tourists during summer season.

The Quetta valley which is an elongated depression is situated between the Murdar Ghar mountain on the east and Chiltan mountain on the west. In the north, the Takatu mountain peak over

shadows it while in the south, it is bifurcated into two narrow valleys by the intervening hillocks of Landi. Its eastern branch taking a slight easternly bend joins in the south with the Spezand-Ismail Khan valley. The western branch terminates at Lak Pass. West of Quetta town the valley has a gap extending from Samungli to Balleli through which it joins the Karanga Lora valley in the west.

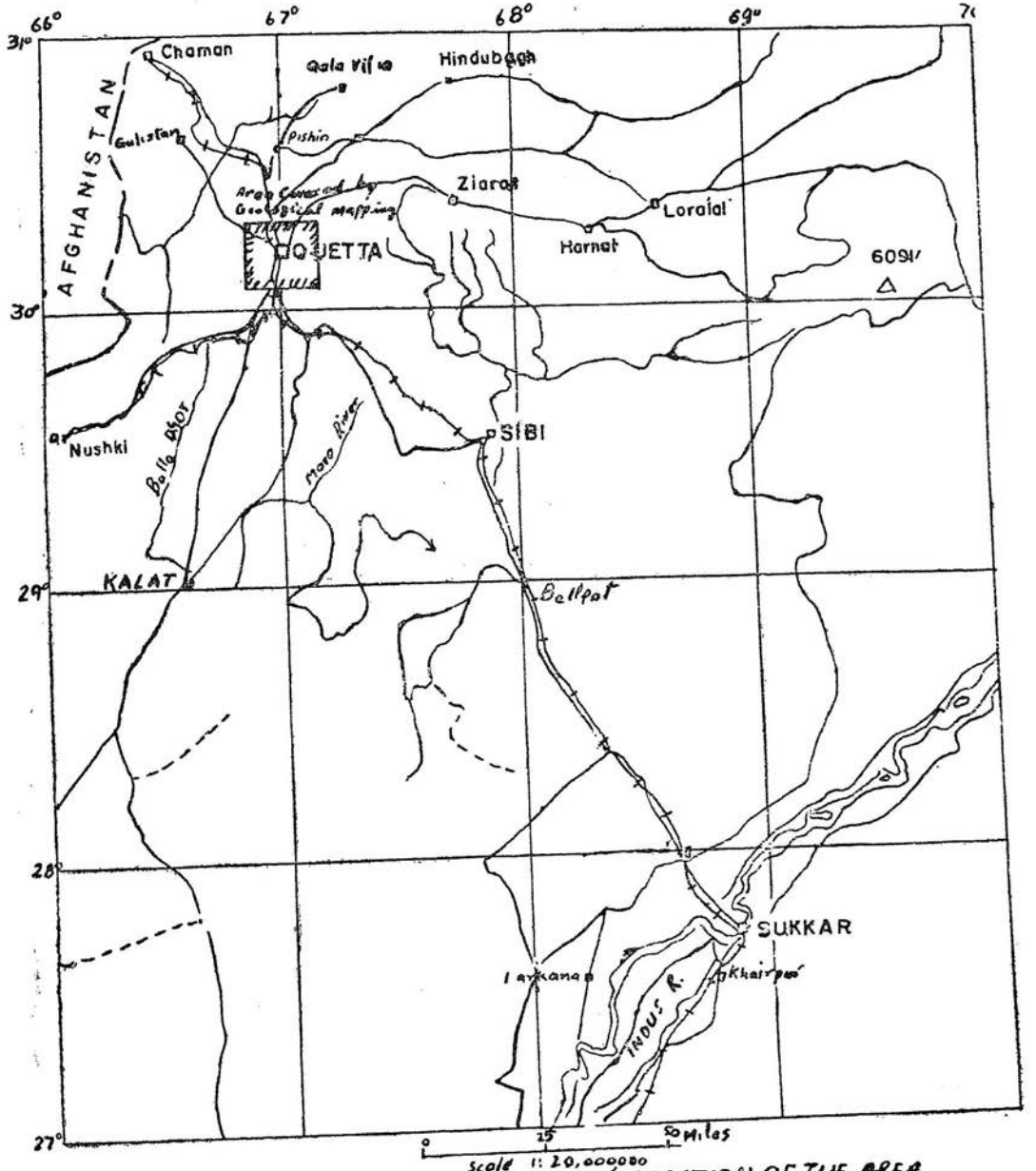
The valley has been carved along a downfold into the softer sediments of Ghazij and Siwaliks.

Stratigraphy.

In the region of the Quetta valley the rocks belonging to the Shirinab Formation of Permian to Early Jurassic age to Recent are found. They are of different competency and thus reacted differentially to the compression. The Chiltan limestone being very thick bedded and massive influenced the formation of flexures and fractures in the area. The folds and faults mostly in the Chiltan limestone are now generally found exposed on the surface in the area.

Geological Formations.

Sibi Group (Miocene) ..	Sandstone, shale, clays, siltstone and occasional conglomerate beds intercalated.
	—— unconformity ——
Spintangi limestone (U. Eocene) ..	Foraminiferal limestone with occasional beds of shale. The limestone is cream, yellow to light grey, pinkish white or chalky white. It is medium to thick bedded.
Ghazij shale (Mid. Eocene) ..	Generally olive coloured, soft, fissile, in places having soft, cleared, grey limestone layers with abundant foraminifera.
	—— unconformity ——
Dunghan limestone (Paleocene) ..	Medium- to thick-bedded, grey, dark grey. Sometimes marly limestone.
	—— unconfirmity ——
Parh limestone ..	The parh limestone is grey or chalky white and



INDEX MAP SHOWING THE LOCATION OF THE AREA

ROADS

DRAINAGE

Railwayline

TRACKS

(Mid. Cretaceous)	commonly has a maroon layer. It is lithographic to porcellaneous; generally medium bedded.
Belemnite shale .. (L. Cretaceous)	Olive grey splintery shales with rare thin layers of limestone in the lower part. The limestone bed increases upward.
	—— unconformity ——
Chiltan limestone (Mid. Jurassic)	It is grey to dark grey in colour and is commonly thick bedded. It is hard, oolitic to finely crystalline.
Shirinab Formation (Permo-Carboniferous to L. .. Jurassic).	Most of the limestone is black to dark grey, medium to thick bedded with interlayered thick shales of light to dark grey in colour.

Tectonic Setting.

The Quetta valley lies in the axial belt of the Suleman — Kirthar Meganticlinorium. Situated in the axial region of the maganticlinorium the folds around the Quetta valley are of the continuous type of Belissov. The valley lies on the western margin of the Sibi syntaxis close to the so called Central Axis. The maganticlinorium seem to have the flat crest as indicated by the sheet dip.

Flexures.

The folds of the Quetta valley are the composite ones in the form of small synclinorium or anticlinorium. The smaller super-imposed folds upon them except in few cases as in the southern part of the Chiltan anticline are not large or complicated enough to interfere with the general simplicity in the outcrop pattern especially in the Chiltan limestone. However, the smaller superimposed folds are present in all the three major anticlinal folds of the area and perhaps also in the Quetta syncline as evident in the outcrop of Chiltan limestone in the Landi hillock. The wave length and amplitude of the superimposed folds, however, in places is large enough in Chiltan limestone to be mapped on 1:50,000 scale.

The following major folds are located in the region of the Quetta valley:-

1. Chiltan anticlinorium,
2. Quetta synclinorium,
3. Murdar anticlinorium,
4. Takatu anticlinorium,
5. Landi anticline.

Chiltan anticlinorium. This fold trends N-S and as exposed on the surface is about 20 miles long. Its width though variable but in places expands upto 8 miles. It exposes rocks ranging from Shirinab to Ghazij. Some smaller folds are superimposed upon it. The prevalent dips are between 30° to 45° on the flanks. A number of longitudial faults which in places pass into transverse faults cut through this fold.

It plunges both to the north and to the south but the southern plunge is almost the double of the northern one. The southern plunge is between 30° to 40°. The culmination lies much closer to the southern 'plunge than that to the northern one.

Quetta synclinorium. This is also a N-S trending fold. The valley which is carved along this fold in places attains a width of about 6 miles. It bifurcates in the area of Landi into two synclines as the anticline of same name here intervenes into it. Almost the whole of this synclinorium is covered by the sub-Recent and Recent sediments. It is only the outcrops in Landi area which give some clue about the structure of this synclinorium. Small folds superimposed upon the major one can be seen here. It seems that this synclinorium follows the plunge of the anticlinoria on the two sides.

Murdar Ghar Anticlinorium. This is also a N-S trending fold and is exposed on thes urface for about 20 miles. It is more than 8 miles in breadth on the exposed surface. Beside, a few small exposures of younger rocks, most of the strata now exposed in this fold belong to Chiltan limestone.

Unlike the Chiltan anticlinorium this fold does not have smaller and well defined folds superimposed upon it. It has on the other hand gentle undulations which have substituted here the smaller superimposed folds. This is the reason that this fold looks a broad crusted flexure with a much bigger wave-length than the Chiltan fold. Its western flank dips at 40° and the eastern one at the low dip of 50° or so.

Compared to Chiltan and Takatu anticlinorium this fold is not intensely fractured and have lesser number of faults. The reverse longtitudinal faults are almost absent and the transverse faults have smaller trough.

It is also a doubly plunging fold with culmination coinciding with the Murdar Peak. The northern plunge is sharper than the southern one.

Takatu anticlinorium. This fold is now so much broken by both the strike and oblique faults that its configuration as a fluxure has almost completely obliterated. Rocks ranging from Shirinab to Ghazij are exposed along this fold. The exposed length of the fold is about 15 miles and the width in places goes upto 6 miles.

The faulting has criss-crossly sliced the fold and displaced the slabs so much that now it is difficult to have a satisfactory picture of the smaller folds or undulations superimposed upon this fold. It is also not easy to determine the amount of plunge and the attitude of its crest and flanks. It is only with the help of the Tertiary rocks rimming it that it can be imagined that it is an anticlinal fold plunging in two sides.

Landi anticline. It is a very small fold compared to other folds of the area. It protudes with a N-S trend in the southern part of the Quetta valley. This fold is now dissected and occurs in three smaller hillocks separated from each other by erosion. It has some smaller folds superimposed upon it. It also shows some faults traversing it

obliquely. Detail regarding its plunge and dips of its flanks is obliterated both by erosion and faulting. In the southern end near the Lak Pass it is tightly squeezed between the Chiltan anticlinorium in the West and the Abegum anticlinorium in the east.

Fractures.

Most of the major fractures in the region are reverse faults, some of which pass into wrench faults and vice versa. There are some faults which also trend along the strike but their main characters are not of a reverse but of a normal fault. It seems that they are strike faults originated due to tension produced by the release in the over pressed state on the exhuastation or the deminution of the compressive force. It is also noted that the type of faulting, the intensity of faulting and thus also the number of faults varies from region to region. The fault regions are as follows:-

1. Faults of Chiltan Region,
2. Faults of Murdar Ghar Region,
3. Faults of Takatu Region.

Faults of Chiltan Region. Most of the faults of this region are high angle reverse faults. They have a big throw as in the case of the fault that passes west of Murree Brewery Gorge. Here the Shirinab Formation has come in the juxtaposition of the Ghazij shale. This fault towards south-west becomes oblique to the strike of the strata and further on passes into a wrench fault. The most interesting feature here is the small folds accompanied by the small faults in the trough area of the syncline, formed in the Parh and Dunghan formations in South-west of their exposures. These small faults are of longitudinal reverse type.

A fault trending almost north-south and passing west of the Chiltan Peak marked 10875 on the map is a wrench fault as it displaces the axes of the folds on its sides but it makes an angle of more than 45° with the stress direction.

The other smaller faults which do not interfere appreciably with the structure of the region are either normal transverse faults or normal longtitudinal faults as indicated by their mode of occurrence in the field.

One of the main faults of this region is that which has been known so far as Chiltan Thrust and which is said to be responsible for the recent earthquakes in the Quetta valley. In the opinion of the author it is a normal fault produced due to the release of compression. The evidences for the same are many. It has much smaller displacement than the thrust mentioned above. This fault does not go oblique to the strike of the strata and passes into wrench fault as is the case with the thrusts of the area. This character is one of the common features of the thrust fault. The main and the most convincing evidence is the hade of this fault which is to the east. It has variable throw along its lineation.

Murdar Ghar Region. In this region it is interesting to note that the greatest concentration of faults is in the northern part of the Murdar Ghar fold. The faults are smaller both in throw and extent than those of Chiltan region. They are both of reverse and normal types.

The fault that is shown by Photographic Survey Corporation trending NN-W-SS-E in the west of Spin Karez and throws up the Eastern side to bring the Dunghan in contact with the Jurassic does not exist. The Dunghan limestone is resting unconformably upon the Jurassic and the Parh limestone. The Dunghan is generally overstepping the older formations in this area. This feature is erroneously shown as fault between the older rocks and Dunghan by Photographic Survey Corporation.

The smaller fractures which are mostly confined to the Chiltan are tear or normal faults. The best example of the tear fault is that of north of Ghawari Nala which off-set the contact of Chiltan limestone and Belemnite shale by about 1500 feet.

The longest fractures of the region that trends N-S and almost traverses the whole length of the Murdar Ghar fold in Chiltan limestone seems to be a normal fault produced by the release of the compression. It hades to the east.

Takatu Region. The faulting in this region is most severe and dominant and except a few faults the rest do not seem to follow the stress pattern. Both the vertical and horizontal displacement along the faults is substantial. It seems that the intensity of shearing has been enhanced in this fold as it occurs at the tip of the Sibi wedge and flowed against it during the orogensis.

The biggest fracture of the area is the one that appears on the map two miles north of Balleli Railway Station and runs north all through the fold. It is a reverse fault and as it is evident from its southern end that it has thrown the Shirinab formation against the Parh. In some places along its length especially in the middle part it slightly ran oblique to the strike of the strata.

The other fault of interest is the one that occurs on the eastern side of the fold and throws up the Shirinab against Dunghan. It is also a reverse fault. In the north it joins both on the east and the west with the major reverse faults.

The rest of the faults are smaller than the ones mentioned above. Some of them are of tear fault type while the other ones are of normal fault type. Their detailed study is somewhat difficult as the marker horizons to assess the displacement and relative movement are not everywhere present.

It is suspected that some of the longitudinal faults of Chiltan region join with the faults of this region.

In this region some small tight folds and faults involving the strata belonging mainly from Parh to Siwalik are also present. Inspite of all this shearing these folds do not influence the structure of the Quetta valley appreciably.

Tectonic Culminations and Depressions.

All the major folds of the are are doubly plunging and form tectonic culmination and depression. It is observed that the plunge is asymetric i.e. on one side it is steeper than on the other. The high peaks of the area i.e. Chiltan, Murdar and Takatu coincide with the culmination of the folds. The gaps which connect one valley with the other as the Balleli gap, Spezand gap, Mustung gap coincide with the tectonic depression of the major anticlinical folds of the area.

Tectonic Interpretation.

The Quetta valley lies upon the axial belt. The folds and faults of this area are the result of the Himalayan Orogency. The folds are linear and continue for 30 miles or more. Their amplitude and wave-length is also quite large. It is because of this fact that the Chiltan limestone being thick bedded and massive acted as a very competent formation and resisted the reduction in wave-length of the folds. It actually controlled the fold and fault pattern of the area. The folds are composite as they have some smaller folds superimposed upon them.

The planes of reverse strike faults and the axial planes of the folds diverge down the Quetta valley and converge upward.

The reverse and the wrench faults are the result of the compression exerted by the Himalayan orogeny. Some of the strike faults e.g. the one that cuts through the eastern flank of the Chiltan anticline seems to be a normal release fault. It has been so far known as Chiltan thrust and said to be responsible for the major earthquakes of the Quetta valley. It is believed by the author that the release of the compression occuring along the longitudinal fractures is responsible for the earthquakes in this region.

The minor structures in the form of joints, cleavage and drag folds are also present. The folds especially in the Parh and the Shirinab seem to be incongrous and do not have any relation with major structure. They may be due to squeezing in of incompetent strata of Parh and Shirinab.

REFERENCES

1. **V. V., Belousov,** Major Problems of Geotectonics, Moscow(1962).
2. **Geological Map of Pakistan,** G.S.P., Scale 1:2,000,000 (1964).
3. **B.A. Sokolov and S.H.A. Shah,** Major Tectonic Features of Pakistan (1966).
4. **S.H.A. Shah.** The Recumbent Fold of Skhobai, Sibi, West Pakistan, Science and Industry (1966).
5. **S.H.A. Shah,** Structure of the area between Ziarat and Wani, Sibi and Loralai Districts, West Pakistan. All Pakistan Science Conference, (1960).
6. **De Sitter, L.U.,** Structural Geology, London (1956).
7. **Hills, E. S.,** Outlines of Structural Geology, London (1953).
8. **Nevin, C. M.** Principles of Structural Geology, London (1949).
9. **West, W.D.** Preliminary Geological Report on the Baluchistan (Quetta Earthquake of May, 31, 1935. Rec. Geol. Surv. Ind. Vol. 69, Pt. 2, pp. 213-240.

66° 45'

67°00

30°00

15'

Shinkozai
Khanai
Zawar
Bostan
Saran Tangi
Kuchlagh
Baleli RS
Samungli
Babozai
QUETTA
Murree Brewery
Basham
Daghari
AJRAM GHAR
MURDAR GHAR
SOR RANGE

SCALE
4 3 2 0 4
8Miles

EXPLANATION

20	Recent Deposits (REC)
19	Subrecent Deposits (SRCE)
18	Bostan Fm. (BO) Kech Cg. (KE) Haro Cg. (HA)
13	Urak Gr. (UR)
12	Murgha Faqirzai Sh. (MG)
10	Spintangi Ls. (SP)
8	Ghazij Sh. (GH)
6	Bad Kachu Fm. (BK) Rattaro Fm. (RT) Brewery Ls (BY)
4	Parh Gr. (PG)
3	Belemnite Sh. (BE)
2	Chilten Ls. (CN) Loralai Ls. (AL)
1	Shirinab Fm. (CN) Alozai Gr. (AL)
	Fault
25	Dip
	Syncline
	Anticline

Khanai Railway Road

I J

A B

Tang Darai CHILTAN Sariab Lora Road LANDI Railway Gwani Road

10000 6000 2000 S.Level 4000

(Murree Brevery) QUETTA (Murdar Ghar)

Karanga Lora Road

C D

G H

Railway Road Boston Road (4) TAKATU (6)(4) Road (10)

THE GEOLOGICAL MAP AND CROSS ECTIONS OF QUETTA VALLEY.(MODIFIED FROM P.S.C.MAP)