GOVERNMENT OF PAKISTAN
GEOLOGICAL SURVEY OF PAKISTAN

INFORMATION RELEASE NO. 154

EARTHQUAKE OF 3RD SEPTEMBER, 1972 IN GUPIS-YAGIR AREA, GILGIT AGENCY, PAKISTAN

By

MAHMOOD U. AHMAD

ISSUED BY ASRARULLAH, DIRECTOR GENERAL, GEOLOGICAL SURVEY OF PAKISTAN, QUETTA.

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Geological Survey of Pakistan, Quetta

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ABSTRACT

An earthquake of magnitude 6 (G.R. Scale) originating in mountains near Gupis, Gilgit Agency, Pakistan at about 10.P.M. on the 3rd September, 1972, rocked the northern region of the country. The shock waves were felt as far south as Lahore, but the damage to the life and property was restricted to the immediate vicinity of the epicentral tract in the Gupis area.

No geological effect, like landslide, rock fall, fracture and fissure opening, or development of a fault track etc., has been noted in the vicinity of the epicentre. Damage to the masonry structures, however, has been observed as far as the town of Singal, situated about 30 miles to northeast-east of the epicentre. The crack patterns which developed in the buildings after the earthquake and the direction towards which the wall etc., fell at the towns of Singal and Gupis, indicate that most of the damage to the property was imparted by the 'compressional' waves.

Aftershocks of considerable magnitudes were still active in the area at the time of the present investigation (late October, 1972). These aftershocks, however, are a normal features and generally follow any sizable earthquake for some time. They are not necessarily an indicative of a larger earthquake which may later follow, as feared by some of the people of the quake-affected area. The area, nevertheless, falls in a very active seismic region (seismic factor 0.2 to 0.1 g) and has been rocked by earthquakes of intermediate magnitudes in the past. It is equally susceptible to the earthquakes of similar magnitudes in the future too.

Disaster by the eruption of a volcano in the area, as feared by some local authorities, is improbable, as no sign of a volcano, old or new, has been reported or observed in the region.

INTRODUCTION

The epicentre of the earthquake which occured at 21 hrs. 48 min. 28.8 sec. (Pakistan Standard Time) on the 3rd September, 1972, has been computed by the US Department of Commerce, N.O.A.A. (National Oceanic and Atmospheric Administration) Boulder, Colorado to have been at 36.0° latitude north, and 73.4° longitude east. The point when plotted on the Survey of Pakistan toeographic sheet numbers 42 d and 43 B falls close to a 15856-feet high un-named peak situated at about 16 miles to south-southwest of the town of Gupis in Gilgit Agency, Pakistan. The area, in general, is occupied by medium grained plutonic igneous rocks of silicic to intermediate composition. These rocks were intruded probably during Early Tertiary period.

The region hither to has not been covered by detailed geological mapping and its structural set up is only little known. Nothing, therefore, can be said as if the earthquake could or could not be attributed to an active fault traceable at the surface. Such earthquakes, however, are generally related to tectonic activities and are caused by abrupt faulting within the earths crust.

Hindu Kush Range due north and northwest of the area is known to be seismically and tectonically very active region. The epicentral area itself falls within a very active seismic region (Kazmi, A.H., 1972), and although it has not been loci of frequent earthquakes in the recent past, its vulnerability to intermediate or even

severe earthquakes is not improbable.

The aftershocks which were still active at the time of the present investigation in late October, 1972, are however, a normal facture. Almost all the sizeable earthquakes are followed by a number of the aftershocks. These aftershocks generally occur in pulsatory manner, and there are generally quite a few small aftershocks within the period of two comparatively larger aftershocks. This phenomenon was noted during the investigation of the Gupis-Tangir earthquake.

Acknowledgement

The author is grateful to Mr. Nasrum-min Allah, Resident Gilgit and Baltistan, who provided free transport from Gilgit to Manimal (near Gupis) and back for the present investigation. Thanks are also due to Mr. Mohammad Akhter Sheikh, Mining Engineer, Gilgit Residency, who accompanied the author for the present investigation, and to the A.P.A. Gupis, who was very cooperative and helpful in providing general assistance. Cooperation extended by the Geophysical Centre, Quetta in providing the data regarding the earthquake is also thankfully acknowledged.

THE EARTHQUAKE

Basic instrumental data of all the sizeable earthquakes are recorded automatically at numerous seismic stations spread all over the world. The time of origin of earthquake, its focus and epicentre, and the magnitude etc., are computed from the basic data obtained from the various stations. Reasonably accurate information is compiled in this way, and is available even for those earthquakes which occur in remote and comparatively less

inhabited areas. The epicentres and foci of the earthquakes computed in this manner, however, are liable to be as far as 25 kilometers (15.5 miles) off from the correct points.

Hupis-Tangir earthquake and the aftershocks similarly were recorded at many seismic stations located in almost all the major countries of the world. The information regarding the earthquake, as computed by the US Department of Commerce, N.O.A.A's (National Oceanic and Atmospheric Administration's) Environmental Research Laboratory at Boulder, Colorado are as following:

Date:	3rd September, 1972.
Time of origin:	16 hrs. 48 min. 28.8 sec GMT (21 hrs. 48 min. 28.8 sec PST)
Focus:	36 kilometers (about 32 miles)
Epicentre:	36.0° lat. N; 73. 4° long, E.
Magnitude:	6.3 MB (G.R. Scale).

For a better understanding of the above information by a person insufficiently versed with seismology, the terms used herein are explained below:

Time of origin: It is the time when the earthquake originates at its focus. As the shock waves travel through the earth they take time to reach to the recording stations. The time of occurrence of an earthquake at certain place, therefore, depends mainly upon the distance the place is situated at from the focus.

The time of occurrence of an earthquake at a seismic station is recorded in GMT (Greenwich Mean Time), which is five hours behind the PST (. Pakistan Standard Time).

Focus: The focus of an earthquakeis a point (or a volume of limited extent) within the earth from where an earthquake originates. The depth of the focus varies considerably in different earthquakes and accordingly, earthquakes are classified as shallow (within 70 kilometres), intermediate (between 70 and 300

kilometers), and deep (below 300 milometers) focussed earthquakes. The shallow- focussed quakes are generally more hazardous than the intermediate and deep focused ones.

The Gupis-Tangir earthquake with 36 kilometers deep focus was thus, a shallow-focused earthquake.

Epicentre: The epicentre of an earthquake is a point (or an area of limited extent) at the earths surface vertically above the focus. The maximum damage to the life and property generally occurs at and in the vicinity of the epicentre, and as the distance increases the earthquake effects are relatively reduced.

Magnitude: The magnitude of an earthquake is a unit designed to measure the relative release of energy at the focus. The more is the release of energy, the more will be the magnitude and the more intense will be the effects of the earthquake at the surface. On G.R. Scale (Gutenberg Richter Scale) 0 is the smallest recorded earthquake and 9.0 is the largest known.

To form an idea of the amount of energy released by an earthquake of magnitude 5.0 Shumsee (1955, p.4) made calculations and reached to the conclusions that it would be 10^{21} ergs. -- equivalent to about 20,000 tons of TNT charge. An increase by one unit in the magnitude would raise the energy release by 63 folds (Asad, 1966).

The magnitude of the Gupis-Tangir earthquake has been calculated to be 6.3-. which would be equivalent to an amount of energy released by a charge of over 20 million tons of TNT. The earthquake, in terms of magnitude, was of a moderate to severe kind, and probably would have produced much more damage to the life and property in similar conditions in case the

epicentre had been closer to a densely populated town.

In terms of intensity the Gupis-Tangir earthquake has been estimated to be that of viii on M.M. scale (modified Mercally Scale) at the epicentre (description of M.M. Scale- appendix II). The earthquake with diminishing intensity was though felt as far south as Lahore but the extensive damage to the life and property caused by the earthquake was restricted to the immediate vicinity of the epicentre (within viii isoseismal contour enclosure- map No. 1). The other places at which the earthquake was felt with the estimated corresponding intensities are as follows:

Places	* Intensity (on M.M. Scale)
Risalpur	V
Peshawar	IV
Rawalpindi	IV
Kohat	IV
Jhelum	III
Mangla	III
Lahore	II
Abbottabad	VI
Tangir	VII
Tabrat	VII

(* Data supplied by the Seismic Section, Geophysical Centre Quetta).

The Political Agent, Gilgit, in his inspection report of 18th and 19th October, 1972, has mentioned "My persistant enquiries in the area revealed that some people had seen flashes of fire and smoke in Sorgan mountains behind Mastuj." The author also was informed by the residents of the quake- affected area of the manifestation of some kind of strange lights at the time of the earthquake. According to the statements of many local people, it appears that though the whole area was illuminated during the

earthquake, no particular source of the light or the flames were seen. The lights probably were comparable to the lights caused due to electrical discharge during a thunderstorm; the only difference being that in this case the lights were more persistant and the source was not visible.

Similar lights, which have been called "earthquake lights", have been mentioned in almost all the reports of large earthquakes throughout the world; yet the actual cause or the phenomenon responsible for these lights is not known with certainity. Some authors, however, suggest that such lights are due to statical electricity produced by the relative displacement of large crustal block during an earthquake (Richeter, C.F., 1958, p.133).

The Aftershocks

The aftershocks of the Gupis- Tangir Earthquake were still active at the time of the present investigation (late October, 1972). An average of 3-4 perceptible aftershocks were occurring every day in the vicinity of the epicentre of the main shock. Except for a few, most of these shocks were of low magnitude, and were felt only in the immediate vicinity of the epicentral area.

It was noted that the aftershocks of the Gupis- Tangir earthquake were occurring in a pulsatory manner, i.e., a large aftershock was followed by a number of frequent smaller aftershocks; and then a comparatively longer quiet period was followed by another large aftershock. The magnitude of the largest aftershock which occurred at 13 hrs. 42 min. 18.1 sec GMT on 4th September, 1972, as is apparent from appendix -I was 5.8 on G.R. scale. According to "Barth's law" the magnitude of the largest aftershock should be about 1.2 magnitude less than the main shock, but in present case the largest aftershock has been only 0.5 magnitude less than the main

shock. This indicates occurrence of an unusually large aftershock.

In some instances, when aftershocks of a major earthquake have comparatively subsided, the area has once again been shaken by an unusually large aftershock. Such shocks have occurred as late as a year or so after the main shock, and accordingly are called "late aftershocks". These shocks have generally been followed by a series of their own aftershocks. The magnitude of the late aftershocks has always been less than the magnitude of the main shock, and unless their epicentres are closer to more populated areas, they generally produce less damaging effects in comparesion to the main shocks.

The aftershocks in Gupis - Tangir area ordinarily would have subsided by now (early February, 1973). If the area in near future is once again shaken by an earthquake of considerable magnitude with following aftershocks, it probably would be the late aftershock, which would be of lower magnitude than that of the main shock. A shock of higher magnitude, or even comparable to the main shock in the area would mean a new earthquake, which as discussed earlier, is always possible in seismically active regions.

The Damages

Investigation for the damages caused by the Gupis - Tangir earthquake have been conducted at several places in Singal and Gupis Tahsils of Gilgit Agency. Following is a brief account of the investigation.

Singal

At Singal, a town about midway between Gilgit and Gupis, the damages caused by the earthquake to man-made

structures are observable. Most of the buildings in the town have developed cracks and quite a few poorly constructed houses have collapsed. The cracks in the well-built buildings, like the Stone-built P.W.D. Rest house, etc., have been noted to follow roughly a set pattern. The western walls of the buildings, in general, have developed vertical to highly inclined cracks, and the northern and southern walls have either developed comparatively low- angle cracks or have remained undamaged. The eastern walls, again like those of the western walls, have developed high angle cracks. Furthermore, the eastern walls of many buildings in the town have been loosen at the joints with the other two walls- probably by the easterly "bush" caused by the compressional waves originating from the epicentre, which was to the west of the town.

No geological effect, like landslide, rock-fall, fracture and fissure opening, or development of a fault trace etc., have been observed or were reported in the area.

Gupis

At Gupis, the damage caused by the earthquake has been more intense than at Singal. Almost parts of all the buildings in the town have either been collapsed or badly damaged.

The northeastern corners of most of the buildings, in general, have been affected the worst. Both the rumbling sounds of the aftershocks, and the shock waves themselves, were felt coming roughly from the south-southwestern direction.

A few persons have been reported being killed by the falling roofs, walls etc., of houses at Gupis. Geological effects, however, like landslides, rock-fall, fracture and fissure openings, etc., have neither been observed nor were reported in the vicinity of the town.

Hamran & Ushkur

The worst affected villages in the Gupis Tehsil are the villages of Hamran and Ushkur, situated at a map distance of about 13 miles to south-southeast of Gupis in Balti Gol (Balti Nalah). Almost all the houses in the two villages have either been completely destroyed, or have severely been damaged. The crack pattern as noted in the walls at Singal and Gupis, have not developed in the mud-wall houses at the two villages; the "debris throw" however indicated a northwesterly push caused by the compressional waves.

Geological effects like landslide, etc., were not observed in the area. Some boulders, however, rolled down the mountain side and thereby (?), at places shallow trenches were formed in the soft alluvium.

Nolti and Sik

The damages at Nolti and Sik villages, which are situated at about 11 miles to southwest of Gupis in the Balti Gol, have comparatively been less. Most of the debris of partly collapsed mud walls, however, were noted to be thrown roughly towards south because of the dilatation waves(?).

Geological effects, were not observed in the vicinity of the two villages.

CONCLUSIONS

As noted at almost all the villages and towns, the maximum damage to the buildings, houses and other masonary structures has been imparted by the compressional waves, and only a little, if any, by the dilatation waves. The author himself had noted the compressional waves to be more pronounced in the aftershocks occurring at the time of the present investigations (the compressional waves, in simplest words, give a push away from the epicentre and the dilatation waves - push towards the epicentre).

There are many variables and the deductions are not so simple but in the simplest model where the epicentral area is divided into four quadrants, the compressional waves are felt in two opposite quadrants, and the dilatation waves in the other two. At all the places where the investigation were made after the Gupis - Tangir earthquake, the compressional waves were found to be pronounced. Probably all the places, from Singal through Gupis to Hamran and Ushkur, (except Nolti and Sik) are situated only in one and the same quadrant, and consequently received only one kind of shock waves i.e. compressional waves. If this is true, according to Hodgeson, J.H. (1964, p. 104- 106), the trace of the fault due to which the earthquake occurred, would roughly be represented by the northwest trending line roughly superimposed on the straight line between the two adjacent quadrants. The fault trace itself, however, may or may not be visible at the surface.

RECOMMENDATIONS

The area, as mentioned earlier, falls within seismically and tectonically active region and is always vulnerable to earthquakes of intermediate to high magnitudes. Nothing, obviously can be done to stop these earthquakes, but well-built buildings with good materials and deep foundation can considerably minimize the damage to the life and property.

Japan is situated in such a region where innumerable earthquakes occur every year. The buildings in the country generally have light but strong walls which can easily withstand moderate to severe earthquake shocks. Similar light but strong walls with local architectural touches are recommended for the area. Roofs of the houses should also be light but rigid. The houses, preferably, should be built on consolidated rocks rather than on loose alluvium.

When planning for a new township in the area the building code, as exists in Quetta, should be adopted. Construction of single close units. are always preferable over open "E" or "L" shaped buildings in the seismically active regions. (Quetta Building Code may be obtained at nominal price from Quetta Municipality).

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APPENDIX-I

GUPIS--TANGIR EARTHQUAKE DATA*

Date	Origin time (GMT) hrs.	Latitude (degrees north) min	sec.	Longitude (Degree east)		Focus Depth (Kilometers)	Magnitude (Mb)	S.No.	Remarks.
3rd Sep'72	16	48	288	36.0	73.4	36	6.3	0	Main Shock
" "	17	46	17.2	36.0	73.3	normal	5.1	1	Aftershock.
" "	23	03	52.1	35.9	73.3	"	5.6	2	"
4th Sep'72	00	14	10.0	35.9	73.4	35	5.5	3	"
" "	00	50	26.7	36.0	73.3	68	5.3	4	"
" "	01	23	49.5	35.8	73.3	normal	5.6	5	"
" "	02	36	17.1	35.9	73.53	36	5.2	6	"
" "	03	51	20.9	35.9	73.5	35	5.3	7	"
" "	06	20	45.1	36.0	73.5	normal	4.7	8	"
" "	13	42	18.1	36.9	73.4	"	5.2	9	"
" "	20	06	24.8	36.1	73.5	"	5.8	10	(illegible)
" "	22	44	08.5	35.8	73.6	56	4.0	11	Aftershock.
5th Sep'72	03	08	00.7	35.8	73.5	45	5.2	12	"
" "	04	07	27.0	35.9	73.4	normal	5.2	13	"
" "	09	13	57.3	35.8	73.4	"	5.2	14	"
7th Sep'72	04	24	15.0	36.0	73.6	"	4.8	15	"
17th Sep'	" 17	33	48.5	35.9	73.3	"	5.4	16	"
18th "	" 21	42	00.3	35.8	73.5	35	4.8	17	"
26th "	" 19	10	31.4	36.0	73.6	normal	4.9	18	"
27th "	" 09	18	11.5	36.0	73.3	62	5.0	19	"
12th Oct'72	00	21	14.1	35.9	73.3	49	5.2	20	"
13th "	" 05	04	36.7	35.8	73.3	normal	5.2	21	"
15th "	" 14	47	53.2	35.8	73.4	63	5.1	22	"

* The data has been computed by the US Department of Commerce, National Oceanic and Atmospheric Administration Environmental Research Laboratory, Boulder, Colorado: and made available to the author by the seismic section, Geophysical Centre, Quetta.

APPENDIX-II

MODIFIED MERCALLI INTENSITY SCALE OF 1931

(Abridged)

I. Not felt except by a very few under especially favourable circumstances.

II. Felt only by a few persons at rest, especially on upper floors of buildings, delicately suspended objects may swing.

III. Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognise it as an earthquake. Standing motor cars may rock slightly, vibration like passing of truck. Duration estimated.

IV. During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls may make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.

V. Felt by nearly everyone: many awakened. Some dishes, windows, etc., broken a few instances of cracked plaster; unstable objects over-turned. Disturbances of trees, poles and other objects sometimes noticed. Pendulum clocks may stop.

VI. Felt by all; many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight.

VII. Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motor cars.

VIII. Damage slight in specially designed structures; considerable in ordinary substantial buildings with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Change of level in well water. Disturbed persons driving motor cars.

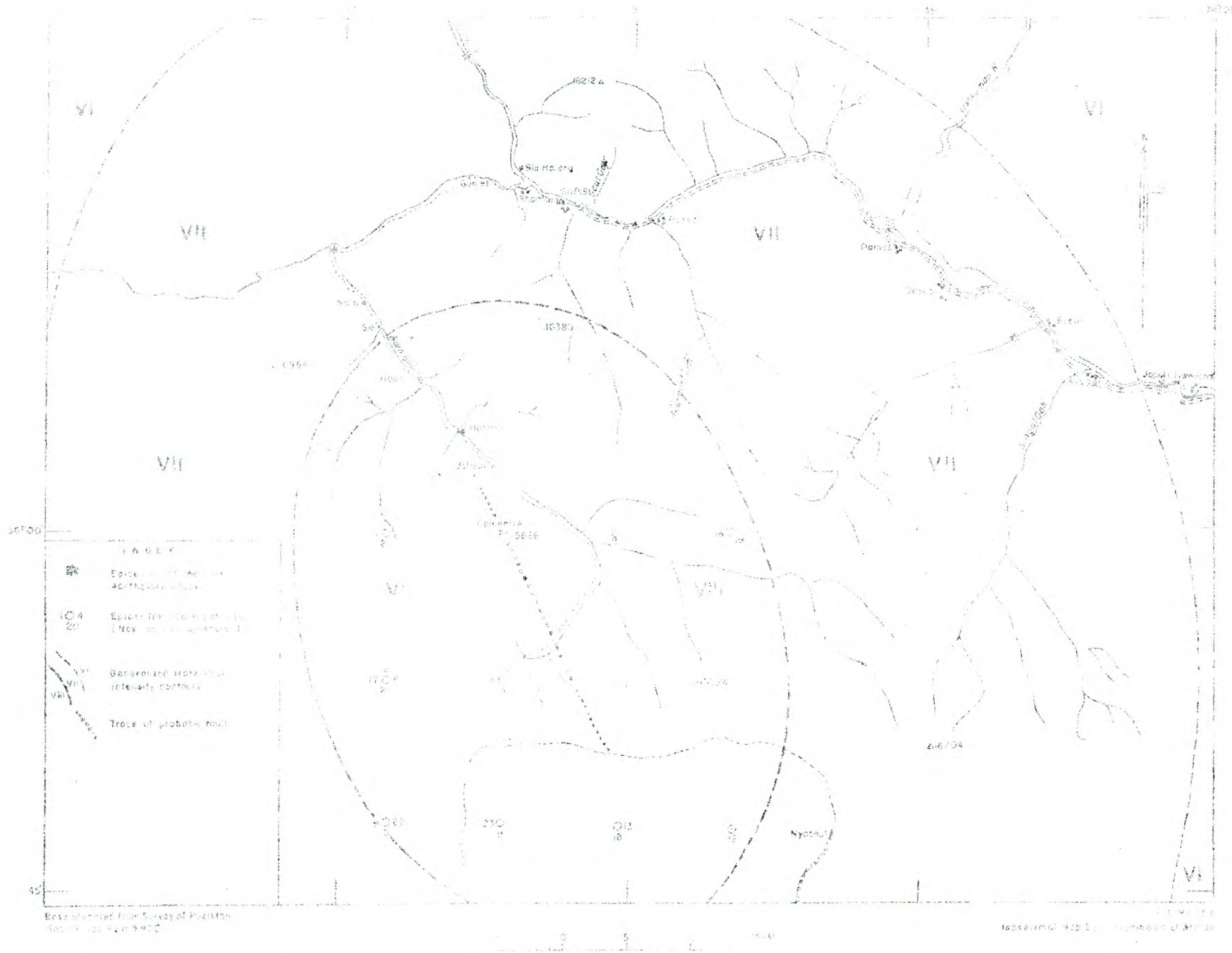
IX. Damage considerable in specially designed structures; well designed frame structures thrown out of plumb; great in substantial buildings with partial collapse. Buildings shifted off foundation. Ground cracked conspicuously. Underground pipes broken.

X. Some well-built wooden structures destroyed; most masonry and frame structures, destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped)

over banks.

XI. Few, if any (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipe lines completely out of service. Earth-slumps and land slips in soft ground. Rails bent greatly.

XII. Damage total, Waves seen on ground surfaces. Lines of sight and level distorted. Objects thrown upward into the air.


VI
VII
VII
VII
VII
VI
Slianasa
Sianolara
Nyoqnol
Epicentre
I N D E X
Base obtained from Survey of Pakistan
Trace of probable fault