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31. *Field Studies of the Kita Mino Earthquake on August 19, 1961.*

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The Kita Mino Earthquake occurred near the borders of three Prefectures, Gifu, Fukui and Ishikawa. The time of occurrence was 14 h 33 m in J.S.T. on August 19, 1961. In the seismic area none could walk during the main shocks which lasted about thirty or forty seconds.

One house completely collapsed under an earth flow at Koike, but many houses in the seismic area are built so rigidly (Fig. 1) that damage to the houses was small. The piteous loss of life was rather more :—8 killed, and 36 injured. The unfortunate loss was due to rock-falls which fell on men as they moved about.

Fig. 1. Rigid structure of a wooden house at Itoshiro.

Fig. 2. Epicentre.

The seismic magnitude was reported by the Japan Meteorological Agency as 7.2, but comparing the relation between the seismic intensity and epicentral distance of past earthquakes, this earthquake was close to the Mikawa Earthquake of Jan. 13, 1945, which occurred about 120 km south. Both earthquakes occurred in the middle part of Honshu Island, Japan, so the results of observations may be compared. The latter earthquake was reported as 6.9 or 7.1 in earthquake magnitude, then the magnitude of the present earthquake may be estimated as 7.

Past earthquakes in the vicinity.

In this region strong earthquakes were frequently recorded near the shore of the Japan Sea. In the mountain area several earthquakes only were recorded in historical records, as seen from Table I.

Characteristic features of earthquakes in this region were (i) damage to house, slight, (ii) loss of life, small, (iii) damaged area, small, (iv) numbers of felt after-shocks, small.

Table I. Past earthquakes in the neighbourhood.

Data	Locality	Damage
1855 3 18	Hida-Shirakawa, Omaki and Hokiwaki Villages	Loss of life, landslide at Hokiwaki and after-shocks.
1858 4 9	Hida, Etchū, Echigo and Kaga Provinces	209 killed, 711 collapsed houses, many landslides.
1891 10 28	Mino and Owari Provinces	7,273 killed, 142,177 collapsed houses, many after-shocks and earthquake faults.
1934 8 18	Gujō-Hachiman Town	
1945 1 13	Mikawa Province (Mikawa Earthquake)	1,961 killed, 12,142 collapsed houses and earthquake faults.
1948 6 28	Echizen Province (Fukui Earthquake)	3,895 killed, 35,420 collapsed houses, 3960 burnt houses and earthquake faults.
1952 3 7	Japan Sea off the coast of Daishoji	

After-shocks.

The numbers of after-shocks observed at the Gifu, Fukui, Kanazawa and other stations of the Japan Meteorological Agency were published by them, and some temporary observation stations were set up after August 24, by the members of our institute. A record of the after-

shocks felt near the epicentre was made at Oshirakawa by a member of the Second Station of the Miboro Electric Powers Station, and is shown in Table II through the kindness of the Dengen-Kaihatsu Company.

Table II. After-shocks felt at Oshirakawa on Aug. 19 and 20.

Aug. 19,	14 h	34 m	(The principal shock)		5 h	15 m
	**	**				20
	17	06				35
		50			6	00
	18	00				04
	19	50				10
	20	24				58 Strong
	21	05			8	45
		47			10	30
	22	10	Moderate		11	53
		34			12	40
	23	13			13	35
		18				50
		55	Violent		15	50
20,	0	10			16	15
		30			17	23
	1	33				26
		43				44
	2	51				54
		53			20	11
	3	54				47
	4	00				54
		05			21	06
		09				11
		28				58
		48				

Information about the earthquakes from inhabitants and writers is listed below: At Nagataki, a woman speaking about the earthquake said that the principal shock was felt in mostly vertical motions, and glass bottles in her house were thrown down. On the next day she felt the strongest shock at 15 h. Considering that in reports from the seismological stations the strongest after-shock was reported at 17 h 07 m on August 20, the writers feel that her memory about the time might be mistaken.

The writers felt three after-shocks at Shiratori at about 13 h on Aug. 23, *P* waves were distinguished from main motions, and they

considered that Shiratori is not very near the epicentre.

On the next day, Aug. 24, the road from Shiratori to Itoshiro was cleared of fallen rocks, and the writers could get to Itoshiro. Dwellers overtaken by the main earthquake stated that the earthquake motion began with loud sound and was prolonged. The senior writer had a similar experience in the case of the Idu earthquake of 1930 at Aziro, and the long duration of the vibrations may be a noticeable feature of strong earthquakes. After-shocks were felt by the writers like the report of a gun close at hand. And they thought Itoshiro was probably the nearest place to the origin of the after-shocks (see, Table III).

Table III. After-shocks felt at Itoshiro by the writers.

Time	Intensity (Japanese Intensity Scale)
Aug. 24 20 h 01 m	III
20 41	II
25 4 15	II
5 50	II
52	III

On Aug. 27 the writers went to Koike, Ōno City, Fukui Prefecture. They felt an after-shock at 13 h 05 m (intensity III) in a house at Okubira, the entrance to Koike, and others at 14 h 21 m and 22 m (Intensity both III) in front of a small shrine above Simo Koike village. In the latter shocks, narrow cracks appeared in the surface soil there, and seemed to close and reopen instantly with the earthquakes.

A postman who encountered the main earthquake by chance at Koike told about his experience: He was about to leave this village at the time of the main earthquake, and could not walk, so returned to the village. He felt many earthquakes there soon after the main earthquake, about one after-shock every five minutes, and the frequency gradually decreased.

Although the number of felt after-shocks from this earthquake was thought to be small, past earthquakes which have occurred in the neighbourhood were similar in the minority of the frequency of their after-shocks.

Rock-falls and Landslides.

The loss of life in this case was unfortunately caused by rock-falls on mountain climbers, and other damage caused by the earthquake was also mostly due to rock-falls, and landslides, or in this case the sliding down of superficial soils and fragments of rocks (Fig. 3). Places where rock-falls and landslides occurred are shown in Fig. 4.

Rock-fall may be a characteristic feature of earthquake damage in this region as recorded in historical materials.

Thin piled layers of cracked volcanic rock, agglomerate and soil are cut out by the rivers and form such steep cliffs that they overhang locally. In such conditions, rock-falls are liable to take place when earthquake motion is strong. The area of rock-falls was roughly in a circle with the radius of about 10 km. This dimension was nearly equal to the area where there was a shifting of gravestones as mentioned below.

A large earth flow occurred at Koike, in the upper reaches of the River Uchinami, and one house was totally destroyed. Fortunately, the dwellers were safely out of doors.

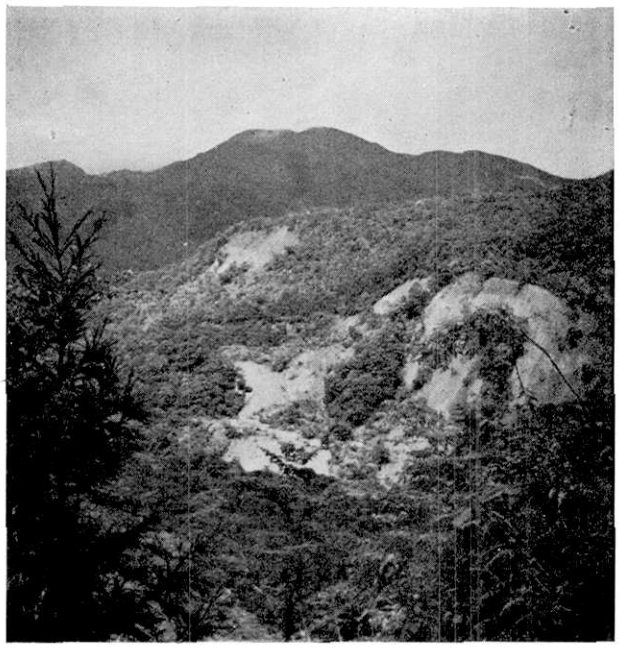

Fig. 3. Landslide and rock-fall at teh western side of Mt. Gankyōji from Koike.

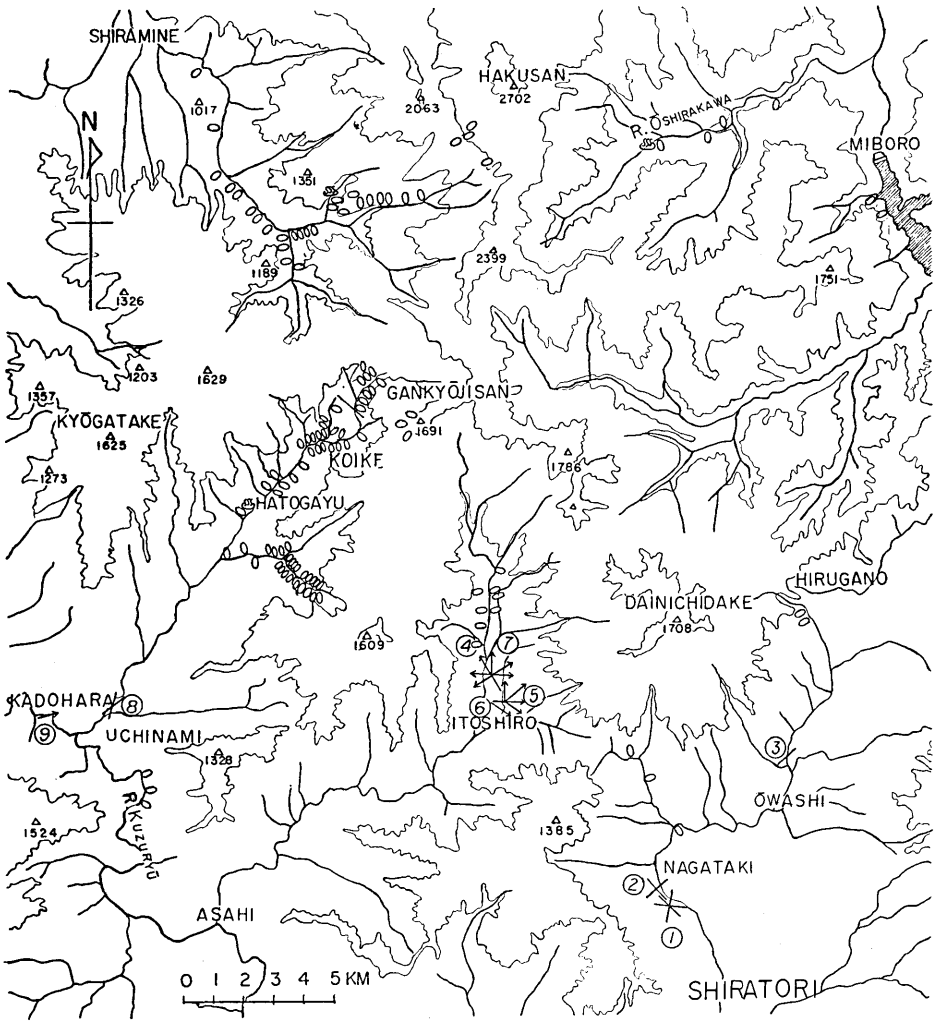

Fig. 4. Rock-falls, landslides (in oblong circle) and displacements of gravestones (in arrow).

Earth Fissures.

Many roads follow the rivers in this region. The surface of the roads was levelled by cutting into the mountain side in some places and raising the level along the river banks (Fig. 5). In June of this year heavy rains fell in this region, and flood waters tore the earth from the sides of the river banks. Then at many places the roads were unstable when the earthquake took place. The soil fell in at the cuttings

and earth fissures opened parallel to the river.

Upstream of the River Uchinami the writers found some earth fissures which were not parallel either to a road or to a river. Near the fissures greyish clay was found, so the writers doubted that these fissures were a manifestation at a geological fault moved by the earthquake. They could not find a clear extension of fault there, because the road was covered with grass at the cutting in the mountain side and with pebbles at the opposite river side, but on the opposite cliff of the river soil and rock slipped off, and there the direction of the river changed along the fissure. Further study of the fissure by geologists is requested.

Overturning and Rotation of Gravestone.

The area damaged by an earthquake is in general proportionate to the magnitude of the earthquake. In the present case the area of the overturning and rotation of gravestones was small; about 20 km in diameter. Since the diameter of the affected area was small, the depth

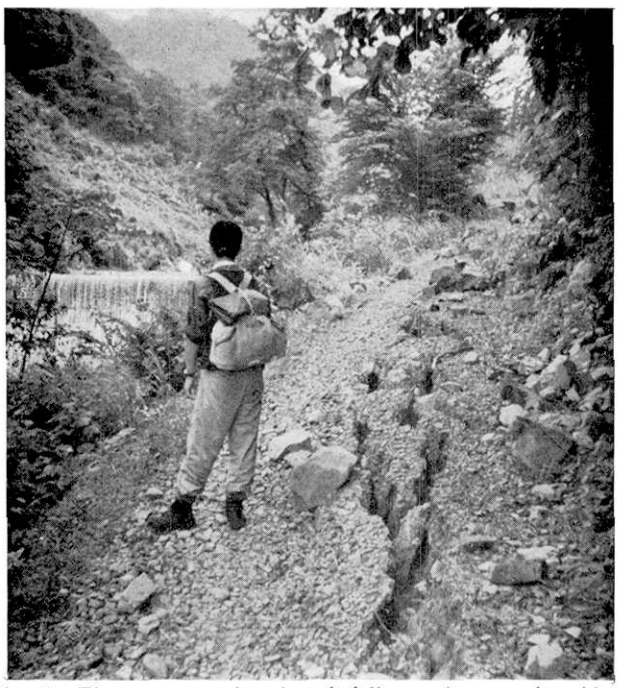

Fig. 5. Fissure on road and rock-falls on the opposite side of the river between Hatogayu and Koike.

of the earthquake might have been shallow. The rotation of gravestones was thought to be rather more numerous than actual overturning. The writers consider that the ground is hard and the amplitude of the earthquake motion was not sufficiently large to overturn the gravestones but only to rotate them. (Figs. 6 and 7).

In the map in Fig. 4 the overturned direction is indicated by an arrow, and final direction of an edge of the rotated stones by a thick line. In Table IV, the places are indicated by using the same numbers as in Fig. 4 ; 3rd column is the dimension of the mentioned gravestones ; 4th column the ratio of breadth (b) and height (h) of the gravestone and 5th column the rotated directions of one face of gravestones before and after the earthquake, or the overturned direction estimated with traces remaining at the face of gravestones. The data obtained were too limited for the epicentre to be deduced from them.

The acceleration of the earthquake motion near the epicentre might estimated about $0.4\,g$ by West's formula.

Change in Underground Water.

Oshirakawa hot spring stopped spouting after the earthquake, and

Fig. 6. Gravestones at Nagataki, Shiratori.

Fig. 7. Rotation of Komainu at Hakusan Shrine, Shiratori.

the mineral spring at Hatogayu and the well at Nagataki, Shiratori, became milky. Most villages used river water which was disturbed by earth flows in many places.

Disturbance of Water in the Reservoir at Miboro.

At the duration of the earthquake the mayor of the town Shiratori, happened to be standing on Miboro Dam and saw water waves proceed with white crests from west to east over the reservoir. A water level meter set at the side of the dam showed traces of the motion of water as large as 40 cm from the mean level of water.

Table IV. The rotation and overturning of the gravestones, etc.

No.	Place	Kind	Dimension	b/h	Rotation or Overturning	Translation
1)	Nagataki (Ashihara In)	Gravestone	18×24×52	0.42	N70W→N80W	
			30×30×77	0.36		6 cm, N45W
			14×20×53	0.35	N50W→N75W	
			15×24×59	0.38	N40E→N65E	
			24×26×70	0.35		2.5 cm, N50W
			28×28×75	0.35		2.5 cm, N 5E
2)	Nagataki (Hakusan Shrine)	Komainu			N50E→N40E	
		Komainu			N50E→N35E	
3)	Owashi	Gravestone	15×22×50	0.40	N35E→N40E	
4)	Itoshiro (Kamizaisho cemetry)	Gravestone	21×21×57	0.35	S50W	
			21×21×59	0.35	W	
			28×21×73	0.36	E	
			26×39×68	0.39	W	
			26×29×68	0.40	E	
			23×20×53	0.40	N	
			24×24×57	0.39	N	
			21×23×53	0.40	?	
			—	—	N50E	
			—	—	S30E	
			—	—	N30W	
5)	Itoshiro (Taishido)	Stone-lantern	—	0.05	S60E	
			—	—	N	
			—	—	S	
6)	Itoshiro (Kubinashi Zuka)	Stone Monument	H=1.5m	—	S60E	
			H=1.0m	—	S80E	
7)	Itoshiro (Chūkyo Shrine)	Komainu	—	—	E	3 cm, W
8)	Shimo Uchinami	Gravestone	26×36×130	0.27		2 cm, N50E
			34×35×140	0.24		5.5 cm, N30E
			25×31×79	0.37		4 cm, N60E
			25×25×49	0.47	N60E→N70E	
			30×45×129	0.33	N20E→N25E	
			40×40×140	0.27	N20E→N25E	6 cm, N25E
			21×21×44	0.43	N20E→N45E	
			—	—	N60E→N70E	
			—	—	N50E→N55E	
			—	—		5.5 cm, N60E
9)	Kadohara	Stature	—	—	N70E	

In concluding this report the writers wish to express their thanks to the Gifu Prefectural Authorities, and people who helped in the study of the earthquake.

31. 1961 年 8 月 19 日北美濃地震踏査概報

地震研究所 { 岸 上 冬 彦
音 田 功

岐阜，福井，石川の三県の境付近に表題の強震が起り，死者 8 名，負傷者36名を出した．人体感覚による震度と震央距離との関係は，1940年 1 月13日の三河地震とほぼ同様であるので，これより類推すると，今回の地震は $M=7$ 程度である．

われわれは 8 月22日より 1 週間にわたつて主に岐阜，福井の両県にまたがつて震災地を踏査した．

i) この付近に起つた過去の地震（第 1 表）

この地方の地震活動性を調べると，日本海に近いところは地震はときどき起るが，大地震は比較的少ない．しかし，日本中部地震帯といわれ，ときどき大地震が若狭湾，伊勢湾，琵琶湖により陸地が狭められた地域を南北に分布して起つている．これらの地震における特徴は落石や山崩れによる被害が非常に多いことである．

ii) 余 震

震央近くにおける余震の観察は電源開発 K. K. 御母衣第二発電所の大白川ダム建設地で行なつていたので，同会社の好意によつて第 2 表に載せた．

一方，筆者らは踏査期間中各地で余震を感じた．岐阜県下においては，白鳥町市街地で初期微動を感じ (23日)，石徹白で急激な shocks を感じた (24日)．余震からの類推ではあるが，震央は石徹白近辺と考えられた．福井県下では，打波川上流の鳩ヶ湯で石徹白で感じたものより周期が長いように思われ (26日)，さらに上流の小池でも同様の感じを受けた．

これらの期間における余震においては推定震度Ⅲが最大で，震動の継続時間は数秒以内であつた，現地の人々の話すところによると，本震は長いあいだ揺れていて歩行困難になつたとのことであり，筆者の一人がかつて同様のことを経験しており，大地震の本質の一部を表わすものと考えられる．

余震の頻度は鳩ヶ湯の下流中村で19日には30分ごとに起つていたが，踏査当日 (26日) には10回くらい感じている．小池では19日夜10時ころまでに 4～5 回強い余震を感じている．これらのことを考えると，いままでの経験から，この地震は多少深いのか，あるいは，この付近の地質による震動特性の違いによるのか問題である．

iii) 落石，山崩 (第 4 図)

この地震の特徴は大きな石の落ちたところが多く，それが原因となつて山崩れを起したところが少なくなかつた．鉛直に近く，またときにはのしかかるような傾斜の急なところの大きな割目をもつ岩石が地震動によつて落ちたのはむしろ当然といえるものが多かつたが，この地震による被害のほとんど全部，特に死者や負傷者はすべてこれら落石，山崩れや土砂崩れによるものであつた．

第 4 図は筆者らの踏査したもののほか，ほかから聞いたもののうち確定できたものは加えてある．しかし，あまり小さなものは省略してある．この分布を見ると，約 20km の直径の円内に入り，墓石や石碑の移動とほぼ同じ範囲となつている．地質との関係は別に述べられるであろう．

iv) 地割れ，地震断層

川に沿つた道の切取面の落石と片盛部分に川と平行に入つた地割れが到るところで見られた．これらの地割れのなかには，この地震の前にあつた同年 6 月 24—29 日の集中豪雨のため堤の土砂が川水にけずられ，土の摩擦による安定を欠いたところも少なくなかつた．

しかし，打波川の上流で小池のわずか下流付近で，道路に直角に入つた地割れが二個所で見られた．粘土状の泥があり，古い断層が今回の地震によつて少し動いたものと思われた．道路に見えた斜めの割目は 10m くらい追跡できたが，その両端は，すなわち川原では転石によつて，他方，山側では草木の繁茂によつて追跡することは不可能であつたが，ただ対岸にも崩れたところがあつて，果して地震断層か否かは地質の研究にまかせる．

v) 石碑，墓石などの移動および転倒 (第 4 表，第 4 図)

大きな地震ほど被害を受ける範囲は広くなることは衆知のことであるが，この地震の墓石などの

転倒した地域は直径約 20km で，いままでの地震と比べて広くなかつた．このことは震源の深さが深くなかつたとも考えられ，iii) で述べた深いということと矛盾するので，結局，今回の地震は大きなものではなく，また震源の深さも深いものではないだろう．地震動が地質に影響されて，振巾が小さく，そして周期が短かいために墓石などは転倒し難く，回転が多く見られたのであろうと思われる．

この地方では，墓石にほぞがつけてあつたり，また新らしいものはセメントで土台に固定してあるものが少なからずあつて，また地震後，直ちに復旧したものが多かつたが，倒れたときにつけられたと思われる墓石の面や角の新らしい傷跡を見て倒れた方向を推定できた．同時にその大きさも測つてきたが，West の公式によつて推定した水平最大加速度は 0.4 g という値が石徹白で見出された．

倒れた方向や回転したあとの方向は震央の近くでは複雑であるが，そこでは上下動が大きかつたと考えれば説明できよう．ここで回転方向というのは，一つの面が地震のあとにどう向いているかを示すものであつて，地震波が短形柱を振動させるときには波の進向方向が短形柱の一つの面と平行になるように回転させると考えると，筆者らの測定した方向か，あるいはそれに直交する方向から墓石の移動や転倒に寄与した波がやつてきたことになる．この考えによれば，震央は石徹白のやや西方となる．

vi) その他

この地域には地下水の湧出しているところが数カ所見られるが，著しい変化を起したのは，大白川上流の大白川温泉で地震直後湧水が止まり，筆者らの行なつた 1 週間後にあつても湧水はみられなかつた．

また，鳩ケ湯の湧水は地震いらい濁つて，1 週間を過ぎてやつと濁りがとれ始めた．そのほか白山北方の温泉には異常はなかつたようである．

白鳥町長滝にある農業組合の井戸水は濁つた．

その他に，注目される現象は，御母衣ダムの貯水池の水に波が立つたことである．同ダムは約 $3\times10^8 m^3$ の水を貯めているが，その表面に波長約 2m の進行波が観察されたが，残念なことに器械による記録はなされなかつた．このことはダムに対して湛水の影響についての新らしい資料であろう．なお，このダムは震央に近かつたにもかかわらず，地震のあとには漏水は減り，またダムの頂が 5cm 沈下したとのことである．

以上の調査については，岐阜県庁，白鳥町役場，電源開発株式会社その他多くの方々から便宜を与えられた．厚く感謝の意を表する次第である．