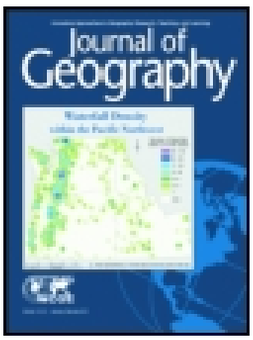

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E. V. Robinson

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A VISIT TO THE AVEZZANO EARTHQUAKE ZONE

By E. V. Robinson*
University of Minnesota, Minneapolis

ON January 13, about 8 a. m. a sharp earthquake was felt throughout central Italy. Rome itself was shaken. A statue fell in St. John's Lateral, new cracks appeared in the column of Marcus Aurelius and minor signs of strain appeared in other places; but little real damage was done in the city and no one was hurt there. One gentleman, indeed, who happened to be shaving when the shock occurred, assured the writer that he had a narrow escape from cutting himself; but he likewise remarked sarcastically that he had no idea how severe the shock had been in Rome until several weeks later, when he received the New York papers. The first reports from the country districts also indicated more alarm than real damage, but late that night it became known that several towns located 75 to 100 miles east and northeast of Rome had been almost completely destroyed.

At first the government was indignant that the responsible local officials had not promptly reported the facts, and it is whispered in Rome that a decree was even prepared removing one of the mayors from office for such neglect of duty. As it happened, however, it proved impracticable to serve notice of removal, for the reason that the mayor in question, together with most of his fellow townsmen, was dead. As soon as the magnitude of the disaster dawned on the public, troops and physicians were hurried to the stricken district. Owing to the complicated international situation, the government announced that foreign contributions would not be accepted, but funds were promptly subscribed in Italy and various relief agencies set in motion.

On February 11 the writer reached Rome and on February 15 went with a party of four, by motor car, to Avezzano, located some 70 miles by road east of Rome. The road (substantially the ancient Via Valeria) follows the valley of the Aniene through Tivoli and up the western slope of the Appennines, descending eastward into an extensive basin without natural outlet. This basin formed the stronghold of the ancient Marsi, who gave the Romans such a severe tussle and later furnished the best recruits for the Roman legions. It is interesting to note that the population of that district still impresses one as distinctly superior in a physical way to the people on the low plains. Crossing the Roman campagna, there were several heavy dashes of rain which helped to make the road all but impassable. In fact, two tires exploded during the run out, which delayed the party so much as to spoil the original plan of making the round trip in one day.

Around Tivoli, olive harvest was in full swing, the people singing gaily as they worked. The snow line was, however, reached at no great distance

*Professor Robinson is spending the present academic year in Europe.—*Editor.*

above Tivoli, and over the higher mountains the snow was piled three to four feet deep beside the road. This snow mantle made it impossible to verify the reports of those who had gone over the road soon after January 13, to the effect that much of the roadbed between Tagliacozzo and Cappelle, on the eastern slope, had sunk some 5 or 6 inches, and that at one place a transverse crevice nearly three feet thick had appeared. The latter crevice, if it ever existed, had of course been filled long before this date.

On the way, a sharp watch was kept for earthquake damage, but none was seen until well across the divide and in fact within a few miles of where the greatest loss of life occurred. Notwithstanding the fact that the shock was felt over an unusually wide area, the zone of destruction was thus relatively restricted. The first clear evidence of the earthquake was a shattered farm building on the hills not far from Cappelle, which also lay mostly in ruins. When we reached Avezzano, the streets were filled so high with wreckage, that the car had to be abandoned and further explorations made on foot.

The Terrible Destruction

In this town of some 16,500 inhabitants, only one building over one story survived, and that was of reinforced concrete. A number of the one story structures survived, but in some cases even where the outside walls appeared intact, the interior had been wrecked by debris from the roof and the inner side of the walls. The completeness of the collapse was due in part to the force and duration of the shock (over a minute), and possibly in part to a compound motion, which seems to be indicated by the fact that the four corner posts of some buildings had all fallen outwards. For the most part, however, the heavy mortality was caused by the construction of the houses. Italy lacks coal, which renders structural iron expensive; and the mountains having been long ago deforested, lumber is likewise a luxury, as everywhere in the Mediterranean region. As a rule, therefore, the houses were built of loose stones of various sizes and shapes, without even timber to stiffen the walls; and most of them lacked effective mortar to hold the stones together. As a result, the walls simply crumbled into shapeless mounds of stone and sand, burying nearly the entire population beneath them. At Avezzano, out of the entire population, 96 per cent are estimated to have perished; and some other places were almost as severely visited.

Owing to the nature of the ruins, the great majority were killed instantaneously. In some cases, indeed survivors were released after several days; and one man, imprisoned in a barn where he could reach water and grain, was taken out alive after 25 days, though (it is said) in so emaciated a condition that his sister failed to recognize him. While our party was there, three persons (an entire family) were laid out in plain pine boxes. For some reason, however, the work of excavation seemed to go on in an unsystematic and half hearted way. There is no place near at hand where the debris can be dumped and the mass of it is too enormous to haul far. Already, in one case, a new village site has been chosen, some 200 or 300 metres away from the

old one; and the ruined houses may quite possibly remain the tombs of many of the victims, as happened after the last great shock at Messina.

On the other hand, every effort is made to provide for the living. Everything has to be brought from a distance—tents, lumber for temporary houses, medical supplies and food. Even water comes by rail, all the wells being poisoned by the dead buried in the ruins. To add to the difficulty of the situation, wolves, driven from the mountains by deep snow, and perhaps also attracted, have followed relief parties going into the hills and have even penetrated into Avezzano itself; three have been killed recently in the central park, where the relief work is now organized. Public kitchens have been opened there which provide a wholesome ration. Schools have also been established in rough shacks at Avezzano which have some 50 or 60 orphans each, collected from the damaged villages. These are under the patronage of the queen. In all relief work, the soldiers have taken a leading part, fairly fathering and mothering the dazed and often helpless survivors, young and old alike.

After inspecting these and other relief institutions and photographing some of the ruins, our party found the hour too late for the return trip over steep and winding curves, with a precipice at one side. It was therefore necessary to pass the night at a town (Tagliacozzo) just outside the zone of destruction. By morning some 6 inches of fresh snow had fallen on the mountains, and the car finally stuck fast on a narrow road at the foot of a heavy grade. For a time the situation seemed a bit unpleasant, especially in view of the wolf stories which we had heard the night before. Eventually the car was turned and run back to Tagliacozzo, the party returning to Rome by train.

Possible Causes

The question remains, what caused the earthquake? Everywhere in Italy this has been the chief topic of conversation, forcing even the war into a secondary place. The most popular explanation has been that the draining of Lake Fucino (the Lacus Fucinus which bulks large on ancient maps) has so far changed the stresses in the crust as to cause internal fractures. In order to judge as to the value of this explanation, it may be well to glance briefly at the nature and history of the district in question.*

From geological evidence it appears that even in Roman days, Lake Fucino was a mere shrunken remnant of a lake measuring several hundred square miles which at an earlier period covered also the high plains of Alba and Palentini, until finally the water level fell below the hill of Cesolino, an extension of Mt. Salviano. Being fed by torrents flowing down the inner slopes, the water level was subject to great fluctuations. Thus, it is recorded that the surface rose 9 meters from 1783 to 1816, fell 12 meters from 1820 to 1835, then began to rise again. During periods of falling waters, the lake was surrounded by a zone of marsh, and when the waters rose again, great distress inevitably resulted. For this reason the idea of draining the lake

*Rossi G., *Studi e Ricerche sull'Ex-Lago Fucino* (Portici 1912); also folios 28 and 29 of the *Carta d'Italia* issued by the Touring Club.

originally conceived by Julius Caesar as a part of his plan for making Rome less dependent on Egypt for grain, was taken up again by Claudius who employed some 30,000 men for 11 years (61-52 A. D.) driving a tunnel over 5 kilometres in length under Mt. Salviano into the upper valley of the Liri. This tunnel, later repaired by Trajan and Hadrian, for a time prevented fluctuations of level; but it was not low enough entirely to drain the lake and it finally became choked up. More than a thousand years later, Frederick II. gave orders for clearing out the Claudian tunnel, but it remained for the Bourbon government of Naples seriously to undertake this work (1826-1835). The complete drainage of the lake, first attempted in 1845-48, was finally accomplished under the direction of Prince Alessandro Torlonia (1852-76), by the construction of a new low-level tunnel into the Liri, with an extensive system of collecting canals. The area drained when the reduced lake disappeared amounted to 15,775 hectares, and the cost was something over 3,000 francs per hectare. Incidentally it may be noted that most of the reclaimed land remained the property of the Torlonia family, whose head still represents that district in the Italian parliament. The Torlonia mansion at Avezzano was among those destroyed in the earthquake, burying some 30 persons in the ruins. This recital of facts seems to dispose of the idea that the drainage of the lake caused the earthquake since the area finally cleared of water was too small seriously to affect the crustal stresses; and the work was moreover completed nearly 40 years ago.

Another popular explanation is based on the assumption (1) that the depression formerly occupied by Lake Fucino is the crater of an extinct volcano like the lakes in the Alban hills and elsewhere near Rome; and (2) that the earthquake was due to volcanic forces, long quiescent but not yet extinct. Color is supposed to be given to this idea by the fact that a severe shock occurred in the same general district in 1214, and another in 1885. However, repeated shocks may be due to faulting quite as readily as to volcanic action; and the western Apennines, unlike the mountains northwest and southeast of Rome. The presumption is therefore against vulcanism as the cause, although the snow made it impossible to determine by inspection whether the district offers any evidence of volcanic action.

Scientific writers, on the other hand, have been cautious in assigning reasons, contenting themselves as a rule with pointing out that the superficial area affected was much greater than in the case of the Messina shock of 1908; that the focus of the latter has been located by Oddone at 9 kolimetres beneath the surface; and that the center of disturbance at Avezzano was probably from 20 to 30 kilometres within the crust. Those speculatively inclined add that there was a center of extremely low atmospheric pressure over Italy; that the moon had just reached (on the 12th) the point in its orbit nearest the earth; and that at the same time the sun showed a particularly violent outbreak of sun spots.

One thing only can be affirmed with certainty: whatever the cause of the earthquake, its effects were especially violent within the area marked by the

highest lake beaches. Nothing is more striking than the relative immunity of towns built on the hills compared to the ruin which befell those built on the plains. Thus Tagliacozzo, on the slope of a mountain where some observers have located the focus of the shock, suffered practically no damage; while Avezzano, located near by on a part of the plain deserted by the lake before historic times, was almost wiped out of existence. Nearly all the towns which suffered severely likewise rested on lacustrine sands and clays, while hill villages in plain sight stood practically unharmed. The conclusion seems clear that the result of earthquakes are far more disastrous on soft and unconsolidated ground.

THE ITALIAN EARTHQUAKE AREA

THROUGHOUT historic times Italy has been visited again and again by earthquakes of the most destructive kind. These disturbances have occurred now in one part of the country, now in another. Scarcely a single locality is entirely free from them, though some parts have suffered much less than others. Among the areas most frequently shaken are the "toe" of Italy, Calabria, and the entire Apennine range.

The center of the disturbance, round the basin of the former Lake Fucino, together with practically the entire region from which severe damage has been reported, is included within an area, roughly forty miles long by twenty miles wide. A few towns outside this area are mentioned as having been damaged more or less, but evidently no more than should be expected from their proximity to the seat of the disturbance.

The earthquake district lies in the very heart of the Apennine Mountains, fifty miles due east of Rome. For the most part it is exceedingly rough. The mountains rise to elevations of 6000 to 8000 feet, while the valley bottoms lie at about 2100 feet. The slopes are very steep and rocky and, in most places, the valleys are deep and narrow.

A notable exception to this condition is found in the neighborhood of the basin of Lake Fucino, where the topographic features are so abnormal that they arrest the attention at once. A glance at the map will show that the lake lay in the center of a nearly level plain, roughly twelve miles long by eight miles wide, set down as it were, into the midst of one of the most rugged parts of the Apennines.

The rectilinear outlines of this sunken area, cutting as they do across the trend of the mountains, seem to indicate clearly that at some earlier time a block of the mountains has dropped down to form the basin of the lake. Other evidences, too, such as the very presence of so large an undrained depression as the old lake basin, and the occurrence of similar though smaller marshy lowlands to the northwest and west, go to show that comparatively recent movements of the earth's crust have taken place in the vicinity and have interfered seriously with drainage.—From "The Setting of the Recent Italian Earthquake," by John L. Rich, in the *American Review of Reviews* for March.