

The Earthquake in Peru

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IN THIS ARTICLE we have pieced together observations of various people. First come eye-witness accounts of the actual earthquake. Then follow reports on relief operations, coordinated by the Peruvian *Comité Nacional de Emergencia*, with particular help from the U.S. Agency for International Development; emphasis is placed on work done by the North American Andean Relief Mission, supported by the American Alpine Club. The article closes with a report on the frightful ice-mud-rock avalanche off Huascarán Norte.

About the authors: Philippa (Pip) Buchanan is Australian, a registered nurse by training and wife of Alex Buchanan, one of New Zealand's finest climbers. Dr. Benjamín Morales, Peru's foremost glaciologist, is in charge for the Corporación Peruana del Santa of preventive measures to lessen dangers which could occur from natural disasters in the region. He is president of the Club Andinista Cordillera Blanca and a member of the Comisión Peruana de Reconstrucción y Rehabilitación de la Zona del Sismo. Eustaquio and Glicerio Henostroza, uncle and nephew, are experienced porters of Huaraz, while Lucio Bustamante is still serving his apprenticeship. John Ricker and Dr. Drummond Rennie, both American Alpine Club members, are well known to our readers. Ricker has traveled the back country of most of Peru and is more likely to be found there than in his native Canada. Rennie, born in England but living in the United States, has worked in high-altitude research on Mount Logan.

The Earthquake

A Few General Facts

On Sunday, May 31, 1970 at 3:23 P.M. an earthquake of 7.8 magnitude on the Richter scale struck northern Peru. Its epicenter was in the Pacific at 9°12' South latitude and 78°48' West longitude about nine miles southwest of Chimbote. The focus is calculated at a depth of some 25 miles beneath the sea. Damage was heaviest in the coastal towns and inland in the Callejón de Huaylas, as the valley of the Río Santa is known where

it separates the Cordillera Blanca from the Cordillera Negra. In terms of deaths, this was the worst disaster ever to strike the Western Hemisphere. Some 70,000 people were killed. In the Santa valley's largest city, Huaraz, over half of the inhabitants, some 20,000 people, died and about 90% of the town was destroyed. Miraculously, apparently none of the mountain porters of the Cordillera Blanca, most of whom live in Huaraz, were killed when the highly unstable adobe-brick houses toppled. Houses of these sun-baked clay and straw bricks with tile roofs supported by wooden beams offer little earthquake resistance. Most of the villages, many of which like Huaraz were up to 90% destroyed, were built on deep, poorly compacted, alluvial deposits with high water tables, which tend to magnify the intensity of the shaking. The earthquake began with gentle swaying, followed by hard shaking which lasted for more or less a minute. There were pronounced side to side movements. Adobe buildings began to fall after about 15 seconds of hard shaking. In the whole region an estimated 1,000,000 people were left homeless. Rockfall on steep slopes also accounted for many deaths and injuries. Strong tremors continued in the region for weeks.

An avalanche fell off the 2500-foot-high, nearly vertical west face of Huascarán Norte: some ten to fifteen million cubic meters of rock, carrying with it some three million cubic meters of ice. The pressure caused by the impact of its fall caused an increasing proportion of the ice to turn to water. This mixture of ice, water, mud, moraine and rock hurtled down across Glacier 511 and down the valley toward Ranrahirca, traveling at a speed of nearly 200 miles per hour. (It took some three minutes to cover the nine miles to Ranrahirca and drop the 13,000 feet.) The track was the same as that of the avalanche which wiped out Ranrahirca and its 3000 inhabitants in 1962, but this time it was much larger and had a higher proportion of rock and lesser one of ice. A portion of the avalanche swept uphill some 650 vertical feet from the river bed and spilled over a hill into Yungay. Although a mere trickle when compared to the main part which devastated Ranrahirca, it snatched away some 18,000 inhabitants of Yungay, and buried them under 35 to 50 feet of debris. Only 241 people who managed to get to the high ground of the cemetery were saved. The two branches of the avalanche rejoined and swept on down the main Santa valley in a wave some 50 to 65 feet high. None of the mountain lakes spilled, as was at first incorrectly reported by the press.

Another completely unrelated avalanche crashed off the northern slopes of Huascarán Norte. This plunged down onto the neck of land between the upper and lower Llanganuco lakes. Tragically it was just this spot where the Czech expedition had placed its Base Camp. One of their number had been killed a few days before while descending from

Huandoy. The remaining thirteen Czechs and the Chilean who was accompanying them were buried under tons of moraine and ice. All that was found were a couple of sleeping bags, a jacket and a box or two floating on the lake.

Rockfall – Pip Buchanan

On May 31 Jeni Williman and I were ambling down the Quebrada Santa Cruz. We idly discussed how safe the big-rock bivouacs used by the local Indian population as they travel up and down the valleys would be during an earthquake. We had spent the last ten days in the mountains, the first four with the Czech party at their Base Camp at 12,675 feet under Huascarán and the following days walking in a wide circle over two high passes, the Portachuelo de Llanganuco and Punta Unión. My husband was 15 or 20 miles away with a New Zealand party on Pucahirca. Jeni and I hadn't seen them since we parted in Lima over two weeks before.

It was hot in the steep gorge of the Santa Cruz as we rapidly lost height on the rough zigzag track winding downwards from high grazing lands towards Huaripampa. At 2:30 we came in sight of the village beyond the rocky walls of the gorge. In the mouth of the gorge we found a small grassy area between the river and the cliffs – an ideal campsite, where we sat in the sun, washed our clothes, heated a hot drink and began the mental process of preparing to return to civilization the following day.

Momentarily I was aware of an acute silence and birds swooping downwards from the cliff. Then suddenly, with the sound of thunder deep in the earth, the ground began moving up and down. Under our feet violent waves convulsed, which we could not see but definitely could feel. Our first reaction was that our little flat was going to fall into the river and we moved instinctively towards the cliffs. Almost simultaneously the cliffs began to fall apart. Rocks flew overhead and the sound of huge, crashing boulders filled our ears. Acutely aware of our vulnerability, we crouched beside a three-foot-high rock and waited, we have no idea how long, for a return of silence and stillness.

The air was solid with dust; we could no longer see the village and the river ran brown and muddy. An 18-inch boulder lay next to my head and one four times that size lay beside my pack. Jeni's wet clothes still lay on the rock at the water's edge but her sleeping bag, five yards from the river, rested on the grass, soaking presumably from splashing boulders. A huge eucalypt tree at the other end of our grassy strip was sliced through eight feet off the ground. We were shaking so much ourselves that we kept wondering if the quake had really stopped.

By the time we had repacked, dust-covered old Indios came down the track, looking as terrified as we. We waited together for ten minutes, in

case we had been mistaken about the “push” and “shock” waves occurring close together at the start of the quake. Another ten minutes and we had run down the stone-littered track, jumping cracks and clambering over the debris of a big landslide, to the relative safety of a small hillock at the mouth of the gorge. Here we met wailing women and children kneeling under a wooden cross, knocked crooked by the quake, staring into the dust and waiting for their men to emerge from the gorge. We sat with them for half an hour, caressing two of the children to calm them and ourselves, when another tremour sent rocks crashing into the gorge again. Since the track out of the village was blocked by a slide and darkness was coming on, we slept in the fields with the villagers.

The next morning, against the wishes of our new companions, we began the walk to the valley and were soon joined by a nine-year-old boy, who wanted to look for his mother in Caraz. What a long twelve miles! The track wound around a steep, barren hillside, in places covered by landslide debris, in others vanished down the slope, and always filled with cracks in the earth.

Strangely, we felt sure that we had been close to the centre of a localized earthquake. This impression was strengthened when we left partially destroyed Huaripampa and passed through demolished Santa Cruz. Here in a field near town were enormous cracks and huge chunks of earth thrown up in confusion. Lower villages were only partly destroyed. However, by the time our little guide had found his mother and we reached Caraz, we realized it was larger than we had thought.

Forty-eight hours after the earthquake there was still so much dust in the air that planes could not assess the damage and helicopters refused to land. As Caraz was completely isolated, to the north by broken bridges, landslides and the blocked tunnels of the Cañón del Pato and to the south by the *aluvión* (flash flood) which had swept away the entire town of Yungay, our only contact to the outside was by a radio, whose valves (tubes) had a life-expectancy of less than 24 hours. Nevertheless they lasted until the helicopters began landing on Tuesday afternoon.

The whole population of Caraz was sleeping in a shanty town sprung up overnight in the fields. There was no bank to change our travellers cheques and no money to buy food, had any shops been open. Though destitute, we were totally accepted by the townspeople. Three families living in the shelter under a willow tree took us in. We were added to the list of mouths to feed, and our handfuls of sugar, porridge and rice were handed out daily by the Guardia Civil.

Each day I went to the makeshift hospital to help, although a nurse who cannot understand the doctors or patients is at a disadvantage. But what a hospital! — no beds, no mattresses, patients lying on the cement

floor with just a poncho for warmth, one bedpan, no water, no plaster or anaesthetics for setting the many fractures. Thank goodness the more serious cases could be evacuated by helicopter to Chimbote and Lima once the dust had cleared.

By Thursday we were feeling the strain. We had no news of our husbands although we had heard the Czechs had all been killed when a giant avalanche swept through their camp. We were having communications problems and nobody knew the true extent of the quake. Tentatively we inquired about the chances for evacuation. That afternoon we were able to fly to Chimbote on separate helicopters; each had a complete load of stretcher cases but full weight had not been reached. When we reported to our embassies in Lima the next day, we received an overwhelming welcome, but it was a few days more before we had definite confirmation on the safety of my husband's climbing party.

As I write this in Huarí, the boys are still climbing and I am working with the American Alpine Club's Andean Relief Mission. Somehow I feel that the work I can do here will help repay in part the hospitality we received from the people of Caraz.

Escape from The Yungay Avalanche – Benjamín Morales Arnao

On a Sunday outing from Huaraz with my mother and two nieces, at two P.M. I bumped into my brother Alberto and his wife at Caraz; they suggested lunch. Almost to my own surprise, I refused the invitation and, prey to a strange nervousness, drove my mother and nieces to Yungay, where we arrived at 2:30. We headed for the restaurant "Los Claveles" in the heart of the old town, where we found numerous friends lunching and discussing the world's championship soccer matches.

I have no idea why we ate so much faster than usual. At 3:05 in the lovely *plaza* of Yungay I greeted Dr. Mateo Casaverde, technical director of the Instituto Geofísico del Perú, who had come to install some geophysical stations in the Callejón de Huaylas. With him was a French geophysicist. I decided to return immediately toward Huaraz. Some nervous impatience made me refuse my mother's desire to buy some of the famous Yungay bread and to visit a relative she had not seen for some time. "We can get the same bread in Huaraz and we'll make the visit some other day."

At 3:18 we cruised through Ranrahirca, devastated by the 1962 avalanche. We arrived at Mancos at the very foot of Huascarán. I drove rapidly along the new road, leaving Tinguá and Pampac behind. At 3:23 we were crossing the Buin bridge, over the river which descends from the Quebrada Uta.

“Look, Benjamín,” said my mother, “See those clouds of dust all over the mountains, especially on the talus slopes.”

“At this time of year they are common enough. The wind is strong and there are little whirlwinds up and down the valley of the Santa.”

As we got to the village of Toma, an adobe brick fell off a house and nearly hit us. More bricks fell into the narrow street and layers of whitewash peeled off the houses. An earthquake! Oh for some open country! I threaded my way through fear-crazed people, who dashed here and there. I could not guide the car any longer on the wildly heaving ground. I stopped the car in an open spot and behind us the houses crashed, nearly closing off the road. Then came a most terrifying roar. It sounded like the flash-flood that in 1941 had roared through Huaraz, killing 6000 people, including some twenty of my relatives. Next it was like a battalion of heavy tanks or a stampede of elephants. The noise was deafening; thousands of tons falling down the talus slopes added to the roar of the avalanche off Huascarán. It got darker by the second as the dust cloud grew so thick that we could hardly breathe.

At 3:40 we crawled on in the car towards Huaraz but found the road completely blocked by shattered houses at Carhuaz. We turned back towards Yungay. In Toma, where the earthquake had caught us, we feverishly cleared a passage, helped by terrified people who acted like automotons. I was frightfully apprehensive as we crossed shaky bridges and crept along sections of the road which had slumped toward the river or gaped open with wide cracks. At five o'clock we passed through Mancos, eerily deserted because all had fled to the hills. I drove on recklessly toward Ranrahirca at 45 miles per hour where possible, despite no more than a hundred feet of visibility in the cloud of dust.

Brakes screeched as I came to a halt at the edge of a blackish track of the avalanche which had swept Ranrahirca into oblivion a second time. Trembling, I got out of the car to examine the 15-foot-high, gooey barrier in which floated parts of houses, broken tree trunks, ice and human remains.

There was nothing left to do now but to return dejectedly towards Carhuaz, but my conscience told me that on my shoulders rested a most grave responsibility for the safety of all the villages of the valley of the Santa. I was in charge of the glaciological work of the region. What steps would have to be taken with unstable hanging glaciers and 265 glacial lakes perhaps ready to break out through their moraine dams damaged by the earthquake? We stopped at Paty, a mile short of Carhuaz. It was the longest and most horrible night of our lives. Tremor followed tremor. We counted during that terrible night 64 distinct, strong quakes.

Two days later I was walking towards Huaraz, fearful of what I should find, when I heard a familiar voice. It was my brother Alberto and his wife, whom we had given up for dead in Caraz. After lunching with their friends, the house where they were was nearly swallowed by a huge crack opened by the earthquake, into which their car disappeared. They had just started in the direction of Yungay when they saw the black mass of the avalanche sweep toward them. They ran uphill and saved themselves in the nick of time by climbing a huge boulder at the moment the flash-flood swept around the rock. They had now just been brought across the track of the *aluvión* by helicopter. I directed them back to Paty, where they embraced Mother and their daughters.

On July 5 I had occasion to fly in a helicopter over the avalanche zone. As we passed over Ranrahirca, we suddenly realized the magnitude of the slide which had been shaken off the slopes of Huascarán. The main mass had rushed down the *quebrada* (valley). Only a comparatively small trickle had swept over the Cerro Aira and down into Yungay, burying the whole city and all but a few of its 18,000 inhabitants.

My friends that we had left in the restaurant had died. Only Mateo Casaverde and the French geophysicist had survived. Mateo had been preparing to return to Huaraz. Fortunately a glance at Huascarán revealed the start of the colossal avalanche. The two ran as if possessed for the cemetery, the highest point in town. As the muck swept about their feet, they gained the steps that led upward. For three nights and two days, with the two hundred-odd other people who were saved, they cowered there amid the opened graves, without shelter, without food, waiting for the encircling mud to harden.

The Earthquake in Huaraz – Glicerio Henostroza

When the earthquake struck at 3:23 P.M., I was in the Huaraz Hospital for treatment of two fingers which had been badly cut two days before. The movement started slowly with a sound like the roar of an airplane. It came in three waves, the last, about a minute after the first, being the strongest. I was outside the hospital when the second one came, having escaped through the emergency room, but I was not the first. Already there were really serious cases, some of whom had been operated on that very day. They were wailing and crying to the Lord for forgiveness. Right ahead of me the ground gaped open a foot wide and closed again. Within seconds a cloak of choking dust enveloped us and kept us from seeing anything. I rushed out into the street to see if anyone was alive out there. The hospital was built of reinforced concrete and so only lost roof tiles, but the whole rest of the city was squashed flat. I rushed up to my house,

which I was convinced would have withstood the quake because I had finished building it only a month before. A crowd of people were hurrying towards the hospital, carrying the injured and corpses. I recognized only my grandmother, who was running back, fearful she would find me dead. My wife, who had left the hospital with my grandmother after visiting me moments before the earthquake, had run home carrying our six-month-old baby to see whether our daughter of 3½ years was alive. Luckily she had gone out with her grandfather to gather corn. I found them all in front of my ruined house, weeping. I immediately rushed to look for Eustaquio's family and found Rosa covered with dust. She had been trying to escape with her two small sons under her arms when the door collapsed; she had to be released by neighbors. Then I went to my grandmother's and my aunt's houses. One of the latter's sons had been crushed and died soon after I got there.

All night the people were outdoors, without food, without shelter. The hospital was a cemetery because it was impossible to care for all the injured; many died for lack of attention who otherwise would not have. The ground continued to shake all night.

For four days we were out of touch with the world. Fortunately we got food from friends who lived outside of town. At the end of four days the dust cloud settled enough so that they could throw us food and blankets from the air.

The Earthquake in the Country – Eustaquio Henostroza

I left Huaraz early on the morning of Saturday, May 30 for the Quebrada Quillcayhuanca because we were rounding up the animals we pasture there. At the canyon entrance I met a large group of friends and relatives. We spent the day rushing about tending the animals and camped that night in a cave. At dawn on Sunday we got up happy with how work was going, but at eight o'clock an unbearable wind sprang up and some left for Huaraz. The rest of us descended later and at 3:10 we sat down for lunch in Unchus (the village right above Huaraz). A few minutes after our arrival the ground began to shake so hard that we could scarcely get to our feet. The houses toppled as if a bulldozer were shoving them over. Almost immediately there was not a house left standing. Like a flash we took off for Huaraz terrified and weeping, fearful for our families. I got to where my house had stood, but no piece of the wall was upright. My wife* and

*When the earthquake struck, Rosa took the two youngest children, each under one arm and following the eldest daughter, rushed for the door. Just before she got out, the front wall of the house collapsed. Although the children escaped unharmed, she was pinned by the debris and injured her back. She had to be released by neighbors.

children, the neighbors and others stood there stunned, wailing, many covered with blood, all white with terror. I headed towards the middle of town to see what had happened to my woodworking shop. It was impossible to get there. There were dead on all sides and injured screaming, some without legs, others half buried and no one to help. I kept on for a way, weeping and shouting like a madman that it would be better to have died than to suffer thus and live homeless. I went back home and my whole family spent the miserably cold night in a field without any shelter. Every half hour the ground would shake again hard. Slowly came the dawn and we awoke with nothing more than that with which we had been born.

The Earthquake in a Village – Lucio Bustamante Valverde

Luckily we were not in the workshop as on many Sundays because our boss had gone to round up animals. We young fellows were playing soccer on the Cachipampa opposite the plaza of Macashca (a village in the hills just south of Huaraz). Suddenly we heard a frightful noise in the north from the direction of Huaraz. Just then the ground began to shake. We fell to our knees to pray as first the old church, which was very ancient, crumbled. The new, one which was still under construction, fell next. Cracks opened in the ground. Those of us who had been playing ran to our homes quickly. Luckily we found few serious injuries or deaths; almost all had rushed outside, though three-quarters of the houses had fallen. Only one old woman and two small children were crushed to death. The women wailed and the children screamed. The level of the water in the river rose suddenly and it was full of mud.

Relief Work

The Overall Picture

The response from all over the world was immediate. The Peruvians coordinated the relief work and organized a National Emergency Committee. Also very active was the United States Disaster and Assistance Team (DAST) of the Agency for International Development (AID). Access by road to the Callejón de Huaylas was out of the question. For several days the cloud of dust, which blanketed the whole region up to 18,000 feet, prevented help from the air. Finally, three days after the earthquake, helicopters began their endless vigil and an airstrip was bulldozed at Anta, a few miles down the valley from Huaraz. Anta became headquarters for relief work, headed by Peruvian Brigadier General Augusto Freyre, ably assisted by Mr. Carson Crocker of AID.

Here was international cooperation at its best. Disaster-aid groups were quickly transported to Peru and the devastated area. Airplanes and helicopters came from Argentina, Brazil, Canada, France and the United States. Germans took over the purification of water in the Callejón de Huaylas. Medical teams arrived. Of particular interest to mountain climbers were the relief missions made up of mountaineers. The American Alpine Club sent a team of 27. The Chilean Socorro Andino had a group of ten people early in the area. A mission of South African climbers came soon. Mountaineers from New Zealand, Canada and Japan also helped. The advantage that alpinists had over other people was that they could move into inaccessible regions to bring help to those who were otherwise cut off from the outside world.

North American Andean Relief Mission of the American Alpine Club – H. Adams Carter

The news of the earthquake came as a frightful shock to the many American climbers who had previously visited the now devastated region. The North American Andean Relief Mission came into being as Bill Phillips and I were agonizing together over the telephone. We had to do something! We immediately got the backing of the American Alpine Club. The quest for permissions fell to me. Bill took over the essential matter of personnel. My wife Ann undertook the necessary work of financial support. Working through U.S. and Peruvian authorities in Washington was a frustrating business. Certain officials were quick to realize how we, as mobile medical units, could operate in otherwise inaccessible regions, but invariably our request for permission to go was lost on the desk of some higher official, overwhelmed by other offers to help. By Friday it was obvious that my only hope was to fly to Lima.

Meanwhile Bill Phillips struggled to find the right people who could drop everything and come immediately. Finally he got the following team put together: Adams Carter and William Phillips, co-leaders, Dewey Blocksma, M.D., Alan Cooper, M.D., Major Craig Llewellyn, M.D., doctors; Philippa Mary Buchanan, Kathleen Moneymaker, Pearl Root, registered nurses; Donald W. Anderson, D.V.M., Jeffrey Duenwald, D.V.M., veterinarians; Roger Glass, Andrew Harvard, James Janney, Louis Reichardt, Todd Thompson, medical students; Nathan Adams, former Army medical corpsman; Richard and Glenn Baldwin, radio communications; Elwood Root, water purification; Lawrence Carter, William Draper, John Ricker, interpreters; Robert Coppock, Colin Davidson, Harry Eldridge, William Patterson, Clyde Smith, mountain climbers. Mrs. Buchanan is Australian and married to a New Zealander; John Ricker is Canadian; the rest are

Americans. In several cases an individual could also fill in under a different category; i.e. a medical student as interpreter or radio operator.

Ann worked valiantly to raise money to cover expenses of the mission. She enlisted the support of the Pan American Society of New England, the Partners of the Alliance, Peruvian Airlines, National Airlines, generous individuals and many others. Indeed, she was so efficient that we collected more than just the essential minimum money, enough so that we could later send funds for specific projects in the area where we worked and to help provide building materials for the mountain porters of the Cordillera Blanca.

In Lima I continued to experience frustrating delays until, after being passed up the line from one person to the next, I eventually found myself in the Government Palace at the top level of authority, which included getting a handshake from the President. Our *médicos alpinistas* were given the area on the eastern slopes of the Cordillera Blanca from Chavín de Huántar to Huari to give medical treatment to casualties and to evaluate the damage caused by the earthquake. The region we were assigned had received scant attention — an overflight or two by aircraft — because the authorities had grave doubts that any assistance could be given in view of the difficulties of communications and of the terrain itself.

Our team assembled in Lima on June 13 and we were flown to Anta in the Callejón de Huaylas. Before leaving Lima, I had arranged for us to be airlifted by helicopter to the center of our region, but on the day of our arrival in Anta the road over the 14,250-foot pass across the Cordillera Blanca was opened and we could proceed to Huari by truck. The 110-mile trip took us two full days. At last we could get to work.

We set up our base of operations in Huari, camping in the patio of the hospital at the invitation of the mayor, who also headed the hospital. From Huari we sent out teams to towns and villages of the region, usually on foot but by truck whenever possible. Work continued until the greater number of earthquake-related patients had been treated. The last clinic was held in San Marcos on June 25.

Luckily there were fewer medical casualties than might have been expected. Few towns on our side of the mountains were completely flattened. Where destruction was great, the town was generally small and the people had been able to escape into open space. There were consequently few victims from crushing. The greater number of earthquake victims on the eastern side of the Cordillera Blanca were casualties caused by falling rocks. The slopes are for the most part steeper than those in the Callejón de Huaylas. Most of the deaths reported and of the injuries treated were the result of rocks which were shaken loose by the quake and hurtled down the mountain sides. Feared epidemics of diseases endemic in

the region luckily did not materialize.

We served a second useful purpose in making a survey of the damage to different parts of the region for the Peruvian government. Having no "axe to grind", our reports could be relied on as being more impartial than those of some, but not all, local authorities, who found it easy to feel that the worse the destruction reported, the greater would be the help given. We had the added advantage of being received with less suspicion by the villagers and *campesinos* of the higher country, many of whom are primarily Quechua-speaking. These people normally request no help of any kind from the authorities in the towns below, having learned from experience that help rarely if ever comes from there.

Although our base in Huari lay only 27 air-miles from the center of the destruction in Huaraz, damage to most towns and villages was less than might have been expected. The worst damage took place at San Marcos, where about 80% of the town was destroyed. Huántar was the other big town of the area which was seriously damaged (50%). Huari, Chavín and Huachis were damaged to a lesser extent. Damage to water canals, used both for irrigation and for drinking water, was great in certain areas such as Huántar, Yaquia, Jatoc. Hours of labor and large amounts for such supplies as cement were needed to put them back into operation. We were able to provide funds to help procure some of these.

Given the needed building materials and cement, the local inhabitants still found themselves in a difficult situation. The earthquake came at a time when crops, particularly potatoes, *ocas*, corn and wheat, were ready to be harvested. If the crops were brought in, a full-time job, there was little time left to repair houses before the rains began in September. If the water ditches were not repaired, aside from problems of drinking water, the next crop would not be successful. The question of what work had priority was a difficult one.

On our arrival it seemed that many of the people were still stunned by the catastrophe and were doing little or nothing. The mere fact of our being there and our interest seemed to help morale and gave an impetus to many to work to help themselves.

We soon found that the most effective working group included a doctor, nurse, interpreter and mountain climber. On arrival in a village, the first three would set up a clinic while the mountain climber surveyed homes, water supply etc., having already helped to carry medical supplies. Persistence was needed on the part of the interpreter to try to question almost every person he met. Local experience in dealing with the people and in understanding their way of thinking was of great help. An interpreter without a knowledge of the social system could introduce his bias into the interpretation. In medical consultations the interpreter had to

be sure that the doctor got unrushed time to consider and treat the case. The throng of idle curious had to be kept at bay as well as those who wanted treatment for minor complaints. We were lucky with our interpreters, several of whom had spent considerable time in this particular region in previous years and knew and were known by villagers.

Rather than to give a complete medical summary of all work done, we report in detail work done by one group. This was composed at all times by Dr. Blocksma, Nurse Buchanan and Interpreter Ricker and was joined for part of the time by Nurse Moneymaker, and Interpreters Larry Carter and Draper. Their schedule follows:

Friday, June 19. Huari to Chavín (bus); Chavín Clinic; to Lanchan and return (on foot); Bl, Bu, R.

Saturday, June 20. Chavín Clinic; to Huari with two patients in evening (truck); Bl, Bu, R.

Sunday, June 21. Huari Hospital; emergency operations on patients:
Bu,

Monday, June 22. Huari to Chavín (truck): Bl, Bu, R, C, D, M.

Tuesday, June 23. Chavín Clinic in AM: Bl, M, C; to Chahuayacu and return (on foot): C; to Lanchan, Jatoc, Chuna, Chavín (on foot): R, D, Bu.

Wednesday, June 24. Chavín Clinic: Bl, Bu, R; to Chahuayacu and return (on foot): C; to Calvario and return (on foot): D.

Thursday, June 25. Chavín to San Marcos Clinic and return (truck): Bl, R.

Falling rock injuries in the high steep farming valleys were the main problem for this group, accounting for five dead at Lanchan alone and 19 of the 24 injuries directly related to the earthquake in this part of the area. Falling debris from houses injured four and one person fell while running in fright. Several of those injured by falling rocks also suffered bruises when they fell after being struck.

Official efforts to estimate damages and injuries were made by the Guardia Civil at Chavín. This effort was made after they knew we were in the region giving treatment. A visit to the *caserío* of Lanchan, where five of the 13 deaths for the Chavin area occurred, was made the day before our planned clinic. The Guardia Civil's statistics were incomplete. They recorded ten earthquake injuries and we treated 24. One person found on the Guardia's list did not live in the *caserío* designated and was not found or treated by us. The Guardia were excellent in allowing us to use their quarters as a clinic, but showed no sense of duty towards our patients in any way.

This group did not limit treatment to earthquake victims for several reasons. Firstly it is sometimes difficult to define an earthquake victim, so

that they attempted to treat all to the best of their ability with the supplies on hand. Secondly, general treatment helped morale, especially where damage to buildings was more severe and the population frightened and nervous. Dr. Blocksma treated the following patients:

Rolling-stone injuries	19	
Falling-house injuries	4	
Fall at time of earthquake	1	
Others related to earthquake	16	(including a miscarriage, chest complaints as a result of sleeping outside, nervousness, and headaches)
Not related to earthquake	<u>47</u>	
TOTAL	87	

Of these patients, nine required a follow-up, but only four of these follow-ups were carried out with any degree of success. Two women with infected wounds associated with fractures (1 skull, 1 humerus) were hospitalized in Huari; one boy whose lip was sutured returned to have the sutures removed after five days; one child with severe pneumonia was successfully treated over a period of time. Of the patients who avoided the needed follow-up, two were more serious. One man with a fractured lower leg and the early stages of gangrene on his feet refused to come down from his *caserío* for treatment; one man with severe lacerations to his hand, leaving tendons exposed, refused to accompany us to the hospital in Huari, although he returned to have the wound dressed.

John Ricker gives further details of our work in the following section.

Magdalena, Pichuichanca, Fortunata against the Mestizos – John Ricker

“Her brains are coming out,” they insisted at the Guardia Civil post in Chavín. Dewey, Blocksma, the doctor of our team, persisted, “Was she conscious? . . . Could she move her extremities? . . . Talk?” “Well, yes.” At least she was at home and had already survived seventeen days after the earthquake.

Home was Lanchán, some four miles above Chavín, in the Quebrada Huachecta. Steep slate walls characterize this *quebrada*¹. The river plunges through a canyon just upstream from the Chavín ruins, which in

¹ Various Spanish terms are used in this article may be explained as follows: *mestizo* = a person of mixed white and Indian blood; *quebrada* = a canyon or valley; *aluvión* = a flash flood, often caused when a mountain lake dumps after its ice-cored dam gives away; *galga* = a rock which plunges down a mountain slope; *caserío* = a village of several houses only.

the past have periodically been subject to *aluviones* from the Huantsan massif at the head of the valley. Above the canyon at Lanchán the gradient lessens; rock walls give way to scree slopes and perilously perched fields of potatoes, wheat and oats. Thatched, one-story adobe and stone houses are scattered in clusters several hundred yards apart. Few were damaged by the earthquake, but a huge landslide had wiped out a large section of the trail at the entrance to the canyon. *Galgas*, rolling rocks, bombarded travellers below the steep slopes, forming impact craters that made the region look as if it had been bombed. Magdalena and her two children had been on the trail when the earthquake hit. A *galga* hurtled down on them, killing one of the children instantly and striking Magdalena's skull. Miraculously the baby on her back survived.

By four P.M. on the first day of our two-day clinic at Chavín, Dewey and our nurse Pip had treated the worst of the casualties that could make it down to our improvised clinic at the Guardia post but there were still injured people in the isolated *caserios* on the Guardia's modest list and others still unaccounted for. Magdalena was the worst of those listed and so up we went. Two hours, they reckoned, even with the detour to the top of the hill to avoid the landslide.

About dusk, Magdalena's son led us off the main trail to the house where they lived. Omnipresent dogs growled and snapped. Curious neighbors and relatives sprang out of the bushes, from behind stone fences and out of doorways to follow us up the last 100 yards to the house. Magdalena was propped against the wall of the covered entrance area. The small baked-mud clearing in front of the house soon filled with chattering neighbors, who displaced braying burros, pigs, migrant chickens, dogs and an elusive cat. Guinea pigs hustled around the floor inside. Spectators were cleared away and Pip removed a decaying sparrow, sitting on bandages of rags, from the top of Magdalena's head. Later, in Pomabamba, Pip found out that the Andean brown sparrow, *Pichuichanca* in Quechua, is used locally to cure headaches. Magdalena assured us that she had a big headache; hence two sparrows, one on the ground beside her. My impression is that the *Pichuichanca* is a last resort and she was expected to die shortly. *Chilca* leaves² covered the 1½ by ½-inch infected wound, which was ½-inch deep and filled with pus. As well she had a star-shaped skull fracture which fortunately was only slightly depressed. The picture of calmness, Magdalena (39) was not complaining and was generally alert before drugs took effect. This would also characterize her behaviour over the next thirty hours that it took to get her to the hospital in Huari.

² *Chilca* is a white flowering shrub or bush of the compositae family. Its leaves are serrate and often sticky. The name is common throughout Peru, although it may not always refer to the same species of the genus. It is used to cover open wounds and also as an infusion to wash wounds.

During treatment, Magdalena's husband and another male relative supported her and relayed information from her in Quechua to me in Spanish and I to Dewey and Pip in English. The men were clad in the dark ponchos of the region and were far more agitated by Magdalena's condition than she was herself. We worked by flashlight. The women relatives clustered in a corner and hovered around a fire, feeding it eucalyptus wood in that economical and efficient way they have. Hot water was soon available. The youngsters kept chasing the livestock off. After an hour and a half Dewey and Pip had turned Magdalena's head into a gleaming white egg. The psychological effect alone of this great bandage was enough to boost morale. Instructions, assorted medicaments, and encouragement were given to the males in hopes that Magdalena would get to Chavín the next afternoon in time for us to take her to the hospital in Huari. Without further treatment she might die, and we emphasized this. We then departed down the trail in the full moon, stopping above the landslide for a glimpse at the 2000-year-old ruins of Chavín far below us.

The next morning we found to our surprise that Magdalena was already in town, resting at a friend's house. They had not carried her down but had brought her down on a horse between 2:30 and 5:30 A.M. That morning we examined Magdalena's child who had not spoken since the earthquake and also treated, to the Guardia's dismay, the town tough, who they claimed was no quake victim but had fractured his arm in a fight. By late afternoon no motor transport had come along the shattered road bound for Huari.

By this time we had persuaded a woman with a crushed arm, badly lacerated, fractured and gangrenous, Fortunata (46), that continued attention in Huari was essential to save her life. This did not happen without argument; both she and her husband wanted her to die at home rather than in a distant hospital. She was also a difficult, nervous patient. Part of the fear was how simultaneously to pay for treatment, a family at home in Chalhuyacu and the living expenses of the husband in Huari. These hill people are at the bottom of the social system and are normally gouged by the towns' *mestizos*. Why should they believe our promise of free treatment? Moreover, the seriously injured or crippled can not work, much less be looked after for a long time; it is better to die than be a burden. Fortunata's husband had a terrible time in town, trying to borrow money for his expenses in Huari.

Two trucks finally arrived, but the drivers were not in the least interested in taking us the three rough hours to Huari — word was out that earthquake victims did not have to pay for transportation. The Guardia gave lip service, but when we were trying to flag down a truck or make it wait, they were nowhere to be seen. The Saturday afternoon crowd in the

plaza gathered to watch us argue with drivers and police. At last we nabbed the third truck and stayed with it all the time it was in Chavín. Luckily the driver had a soft load of *coca* and our two patients were helped aboard, although the driver asked why we were taking these dead people to Huari. At Huari he would not even drive the extra two blocks to the hospital. We carried the patients ourselves and put them in the first handy ward, which turned out to be the men's. Our doctors cooperated with Dr. Cachay, the head of this rural hospital, until we had to leave. The two husbands found work in the Bishop of Huari's irrigation repair projects.

In late July Pip returned through Huari. Both patients would stay no longer and had returned home. Dr. Cachay assured her that Magdalena's head wound would heal, but Fortunata's arm would depend on her own ability to carry out treatment for herself.

Relief Work by Helicopter – I. Drummond Rennie, M.D.

After my arrival in Lima, as there was no transport into the Callejón de Huaylas, I spent time finding out about equipment, hospital beds and personnel needs in Lima and sent reports to the American Embassy. On June 10 Mr. Carson O. Crocker took me up to the Callejón by air. I worked for a bit in the field hospital in Anta, but the next day, with Arturo Soriano, who had commandeered a jeep, and two other climbers, I went down the valley to the slide (*aluvión*) at Ranrahirca. The trip showed me that the medical situation on the floor of the valley was well taken care of. Members of the Chilean Socorro Andino (Andean Relief Mission) were working exceedingly hard. At Ranrahirca I met Japanese climbers who had seen the Czechs overwhelmed by an avalanche during the earthquake. I spent the next day or two trekking up into villages remote from the road, where even burro paths had been wrecked. As well as treating a large number of patients, I did a survey. This showed few injuries or deaths up in the small villages because the people had rushed into the open air when they felt the first tremors. There was no starvation and no epidemics. Such a survey had to be extended and to do so on foot would take even a large number of people months. I then returned to Lima and put in a report. Though I had made arrangements to return to Chicago, I was recalled to the valley to put my plan into operation since helicopters had become available in the Callejón. I returned on June 15 and immediately got hold of as many volunteer doctors and nurses as I could, about 30 in all. They were divided into two groups and provided with simple first-aid equipment and medicines. With five or six packed into each helicopter, we would fly into the remote villages, high up in the side valleys of the Callejón,

especially in the northern part around Corongo, where the terrain is extremely mountainous, steep and broken up. We would be dropped into the villages in rotation and then after a few hours would be picked up by the helicopters, along with any injured who required evacuation. We would then be flown to another village. In each village we would take surveys of damage, water and food needs, the requirements for shelter, blankets, etc. I would gather all information once we were back in Anta and then report to General Augusto Freyre. This enabled us to pinpoint places for C-130 airdrops. In all we visited dozens of villages and treated a great many people. But especially, I think we gave the people a little hope.

South African Peruvian Relief Committee

Organized under the direction of the mountain climber, D.R. Reincke, South Africa sent to Peru a fully equipped and self-contained relief team of twelve people, doctors, nurses, interpreters and relief workers, all of whom were experienced mountaineers. This group was led by Dr. Robin Sandell and Harold Hill. Although they would have been capable of operating in a more inaccessible area, the Peruvian authorities requested that they take over the hospital in Carhuaz. The first team worked there from June 20 until July 10 when a second team, led by Dr. Victor Knutzen and Dr. George von Tomann took over and continued until August 2.

Technical Notes on the Huascarán Avalanche, which Destroyed Yungay – Benjamín Morales Arnao

On January 10, 1962 a catastrophic avalanche swept over the town of Ranrahirca. At that time I had the opportunity to study it and determine its causes. There had been no seismic movement; it was initiated by the violent fall of a large section of the western edge of the icecap which bordered the 2500-foot-high vertical granite cliff of Huascarán Norte. This mass of ice stripped away with it a considerable volume of rock from the west wall of Huascarán Norte, which since that date has slightly overhung the valley. After the 1962 avalanche the amount of ice deposited on the outwash cone of Ranrahirca was considerable, huge melting ice blocks still being easily visible two weeks after the slide.

On the other hand the avalanche of May 31, 1970 had very different characteristics. This was triggered by the seismic movement which shattered the rock structure of the west face, because the granite had a system of fractures nearly parallel to the face with an angle from 80° to nearly vertical. That is to say, there already were immense rock slabs nearly

separated from the bedrock and counterpoised. This structure allowed a great part of the face of the cliff, over 2500 vertical feet in height, to break off and fall, dragging with it the mass of ice that crowned it. Therefore the cause of this avalanche was not of a glacial type but rather mechanical, induced by the collapse of the rock structure.

When the enormous quantity of rock, estimated at between 10,000,000 and 15,000,000 cubic meters, fell from the cliff, it carried with it its covering of ice, estimated at some 3,000,000 cubic meters. This mass of rock and ice picked up and dragged along with it rock and ice from some parts of the cirque of Glacier 511. We have determined that this glacier itself did not lose much of its volume by the passage of the avalanche, which seems rather to have ridden over it. As the colossal mass of rock and ice left the glacial zone and entered the zone of moraine, it already carried a rather large percentage of water, which had been converted from ice by the caloric energy generated both from the initial fall and its onrush.

Thus began to hurtle downwards towards Yungay and Ranrahirca a mass which had a high percentage of rocks from the Huascarán cliff and a smaller proportion of ice and semi-viscous material formed by water mixed with morainal debris. This heterogenous complex rushed forward at the incredible speed of about 300 kilometers (186 miles) per hour, preceded by a cloud of dust and ice particles, which reached a very high altitude. Witnesses affirm that the avalanche passed over Yungay and Ranrahirca, 14 kilometers (9.5 miles) from Huascarán, in between three and five minutes after the earthquake.

Yungay had been considered by Peruvian and foreign experts to be one of the safest centers of population in the Callejón de Huaylas as it was protected by the Cerro Aira, a hill that rises 200 vertical meters (656 feet) above the bed of the Río Llanganuco; but the city was overwhelmed by a small branch of the avalanche, which swept over the top of the hill and left in its track immense boulders weighing over 4000 metric tons. The main body of the avalanche swept down over Ranrahirca. The amount of debris deposited on Yungay and Ranrahirca is estimated at 70,000,000 tons, three times the amount left by the 1962 avalanche. The amount of ice was less in 1970 and had mostly disappeared at the end of a week. I examined the debris near Ranrahirca two hours after the avalanche occurred. It was a blackish, semi-viscous mass with moderate-sized ice blocks mixed in indiscriminately.

In the days right after the earthquake we had the opportunity to receive eminent scientists from all over the world, who came to offer help. I wish to thank for their invaluable collaboration scientists from the United Nations, the United States, South Africa, Chile, France, New Zealand, Japan, Germany, Canada, Switzerland, Czechoslovakia, Russia

and other countries who did their utmost to help us solve in these difficult moments the prodigious problems that faced us. I must mention in particular a project carried out together with a United Nations team in which we had the help of helicopters to reconnoiter doubtful glacial lakes and terrain. Together we reached the following conclusions:

1. The earthquake did not provoke major avalanches in any of the numerous hanging glaciers of the Cordillera Blanca, except for the one from Huascarán Norte.
2. Catastrophic avalanches from hanging glaciers are more likely to occur from a failure in the mechanical structure of the rock than from the effects of glacial dynamics. That is to say the massive discharge of rock which sustains hanging glaciers depends on the type, orientation and inclination of the fractures that penetrate the rock masses.
3. It will be necessary to study systematically the rock masses which sustain the hanging glaciers to determine their potential danger.
4. It will be necessary to make geothermic studies in glacial areas in order to determine isothermic zero and the zones of temperatures above and below zero, depending on the altitude.

As a corollary to these studies it is obvious that adequate study and control of glaciers and lakes in the valley of the Santa must play a dominant part in urban rehabilitation and construction. With this end in mind, the government has appropriated a considerable sum of money to be used in 1971-72 for the security of the valley. Four tunnels will be dug in the natural dams of glacial lakes to reduce water levels. Dams will be strengthened and outlets enlarged in five more lakes. Some 50 kilometers of access roads will be built to high valleys. The Reconstruction and Rehabilitation Commission has set up basic criteria for the relocation of towns in the Callejón de Huaylas:

- a. Catastrophes which are produced by avalanches that fall from hanging glaciers may well recur in the future. There is no way to avoid or control phenomena of such magnitude. Consequently towns below such glacial areas should be relocated.
- b. Catastrophes which are a result of the violent overflow of glacial lakes may be controlled by lowering water levels by means of tunnels through moraine dams or by enlarging outlets. Therefore towns below glacial lakes may remain in the same location, provided the problem of control of the lakes is solved.

For these reasons, Huaraz and Caraz may be reconstructed on their present sites. On the other hand Yungay, Tinguá, Mancos, Ranrahirca, Tinco, Toma, Carhuaz, Marcará and Paltay must be moved to locations which will be from 500 to 7000 meters from their present sites.