発生日時／Date and Time [Local Time]	15:23, 31 May 1970	被害／Damage	
震央／Epicentre [Lat., Lon Depth]	9.15°S, 78.83°W, 43 km	死者／Deaths	40,000～70,000
規模／Magnitude [Richter Scale]	7.6	被災建物／Damaged buildings	200,000

地震と被害概要

震央は、ペルー北部、チンボテ：Chinbote市の沖25kmであり、ナスカプレートと南アメリカプレートの接点付近の地震多発地帯。被災範囲は、震央から半径150kmの地域であり、被害量としては、ラテンアメリカで最大である。

震央に近いチンボテ市では、家屋の75%、特に日干し煉瓦で造られたアドベ造の96%が倒壊し、1,000人の死者が出た。しかし、被害を拡大させたのは、雪崩とそれに続く土石流であった。アンデス山脈にはさまれたサンタ峡谷では、地震前の30年間に8回の雪崩に襲われ、1962年にはランライルカ：Ranrahirca市で4,000人の死者が出た。

震動により、ペルー最高峰ワスカン：Huascaran山（海抜、6,768m）の標高5,500～6,000mの地点では、万年氷と岩が崩れ、幅2.4km、高低差1,000mの氷河上を滑り落ちた。これは、さらにモレーン（氷河堆積物）の土石を巻き込みながら、距離10km、標高差3,000mを3分で落下し、途中、比高230mの尾根を6,000トンの岩石が乗越え、高さ約30mの壁となって、ユンガイ市：Yungay市と前述のランライルカ市を襲い、それぞれ、17,000人、1,800人を生き埋めにした。人口2万人のユンガイ市の生存者は、400人足らずであった。土砂は、サンタ川の対岸83mにまで駆け上がり、8kmにわたって3～10m堆積し、その総量は、0.5～1億トンと言われ、サンタ川下流にも大きな被害をもたらした。

ペルー政府は、旧ユンガイ市の地域を発掘禁止とし、隣接した丘の上に、小規模な新集落を再建した。また、この被害を教訓とするために、最近、ペルー政府は5月31日を「防災の日」としている。

The Earthquake and Resulting Damage

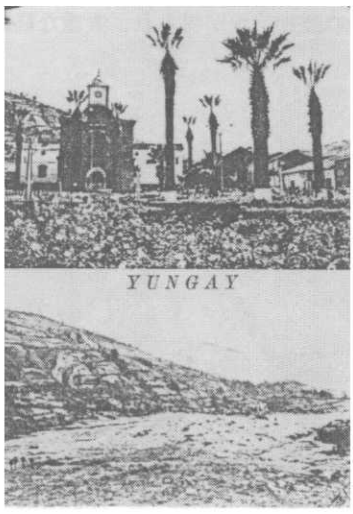
The epicentre was 25 km off the coast of Chinbote, in the north of Peru, where the Nasca Plate meets the South America Plate and earthquakes frequently occur. The radius of the damaged area was 150 km. It was the biggest earthquake disaster ever recorded in Latin America.

In Chinbote, 75 per cent of the houses were damaged. Especially, 96 per cent of Adobe structures were destroyed. In the city, 1,000 persons were killed. It was the avalanche, however, which worsened the damage. Avalanches have attacked the Santa Valley in the Andes Mountains eight times in thirty years. In 1962, 4,000 persons were killed in Ranrahirca city.

A mass of ice at the 5,500-6,000 m level on Mt.Huascaran(6,768 m), the highest mountain in Peru, fell, slid on a glacier and dropped a further 10 km. It took only three minutes to reach Yungay and Ranrahirca. It killed 17,000 persons in Yungay and 1,800 in Ranrahirca. In Yungay, only four hundred persons out of the 20,000 population survived. The avalanche also reached the opposite hill of the Santa Valley 83 m away. Three-10 m thick earth and sand layers covered an area of 8 km². The total volume of the landslide was 50-100 million tons. The downstream area of the Santa Valley was also affected.

The government of Peru prohibited the excavation of the former settlement of Yungay, and constructed new small-scale settlements on the nearby hillside. From the experience of this earthquake, the government of Peru has recently designate the 31st of May as the day for disaster prevention.

Avalanches and Rockslides on Mt Huascaran



Top: Yungay City before the Earthquake
Bottom: Ruins of Yungay City after the Earthquake

発生日時／Date and Time [Local Time]	6:00, 9 February 1971	被害／Damage	
震央／Epicentre [Lat., Lon., Depth]	34.4°N, 118.43°W, 13 km	死者／Deaths	58～66
規模／Magnitude [Richter Scale]	6.6	被災建物／Damaged buildings	23,109

地震と被害概要

震央は、ロス・アンゼルス：Los Angeles市の北北西45km、サン・フェルナンド：San Fernando市の北北東12kmであり、サン・フェルナンド市にとっては、ほぼ直下型地震である。被害は、長径70km、短径40kmの楕円状の地域に限定されている。死者の大半は在郷軍人病院：Sylmar Veteran's Administration Hospitalの崩壊によるものである。

建物被害は、学校、病院、住宅等広範に及び、大破建物は5,400棟以上である。土木施設の被害としては、サン・フェルナンド市の中心から3kmにあるヴァン・ノーマン・ダム：Van Norman Dam（アースダム）の堰堤が崩れ、決壊の危険性があったため、下流の住民8万世帯に避難命令が発令されたが、迅速な措置によって、ことなきを得た。さらに、山麓部のインターチェンジにおける高架橋の落橋が目だち、電話局の被害や変圧器の転倒等により、通信・電力にも大きな影響が出た。また、サン・フェルナンド市では、500ヵ所以上でガス管が損傷し、28ヵ所で出火（出火件数の合計は62ヵ所）し、約12㎢、12,000世帯に影響を及ぼした。

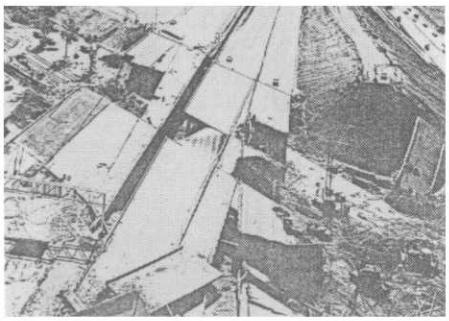
以上のように、サン・フェルナンド地震における被害は、発震時刻が早朝であったため、限定的なものであった。しかし、近代都市を支える電力・通信・ガス等の被害によって、都市機能全体が麻痺することが示された。さらに、一部の調査報告書は、都市機能を支える、上下水道等の水供給系、電力・ガス等のエネルギー供給系、道路・鉄道等を含む交通系及び通信・電話等の情報系を総称する「ライフライン：Lifeline」という言葉を用い、これがその後の都市震災対策における重要な視点となった。また、南カリフォルニアでは、地震前から地震観測網が整備されていたため、この地震では数多くの強震記録と建築物の震動状況が得られ、貴重な経験となった。

The Earthquake and Resulting Damage

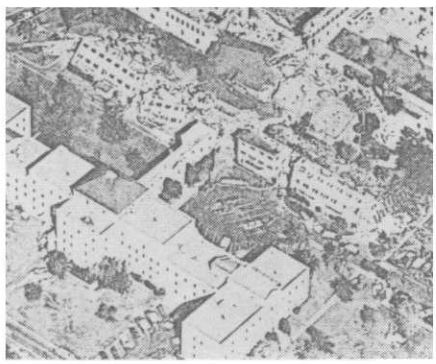
The epicentre was 45 km north-north-west of Los Angeles, or 12 km north-north-east of San Fernando. The damaged area was an elliptical shape with a major axis of 70 km and a minor of 40 km. The major cause of death was the collapse of Sylmar Veteran's Hospital.

Over 5,400 buildings were destroyed, including schools, hospitals, and houses. The bank of Van Norman Dam, which is located three kilometers away from the centre of San Fernando, was damaged and was in danger of collapse. Evacuation orders were issued, therefore, to eighty thousand families in the downstream area. Immediate response measures, however, helped the people recover from the crisis. Elevated bridges at intersections on the highways in mountainous areas were destroyed. Due to the fall of voltage transformers and damage to telephone stations, electric power supply and telecommunications were affected. In San Fernando, gas pipelines were damaged in over 500 places, and a total of 62 fires broke out in 28 places. The total affected area was 12 km², and 12,000 houses were damaged.

Because the earthquake occurred early in the morning, the scale of the damage was limited. However, the damage to electric systems, telecommunications and gas services have shown that the entire urban function could be easily paralyzed. Some of the research report started to employ a new term, "lifeline", to refer to the systems supporting urban infrastructure, such as water and sewerage systems, electricity and gas services, transportation systems, and information systems. "Lifeline" has become the focal point of preventive measures against earthquakes in urban areas. In southern California, a network for earthquake observation had been established well before the San Fernando Earthquake. The earthquake, therefore, turned out to be a good opportunity to strengthen the network, providing it with a number of earthquake records as well as reports of building conditions.



Destroyed Elevated Bridge at Highway Intersection (Robert Lacopi, "Earthquake Country", Lane Publishing Co., pp 138)



Collapsed Sylmar Veteran's Hospital (Robert Lacopi, "Earthquake Country", Lane Publishing Co., pp.37)

発生日時／Date and Time [Local Time]	0·28, 23 December 1972	被害／Damage	
震央／Epicentre [Lat., Lon., Depth]	12.33°N, 86 13°W, 5 km	死者／Deaths	5,000～18,000
規模／Magnitude [Richter Scale]	6 0	焼失建物／Burned buildings	50,000～

1．地震と被害概要

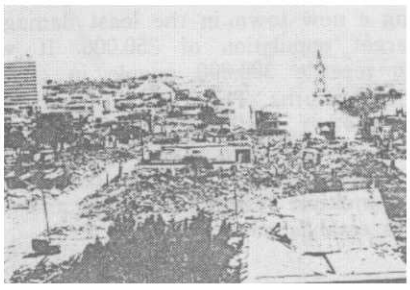
震央は、中米；ニカラグア：Nicaragua の首都であるマナグア：Managua 市のほぼ直下。本震後、40分間に地震（M＝5 6程度）が3回発生した。マナグア市の中心部は、かつてマナグア湖の一部であったと考えられており、付近の火山活動によって噴出した火山灰・火山礫等が複雑に堆積した地盤上に立地している。被害は、この複雑な地盤上の半径数kmの範囲に限られている。

建物被害は、当地方の伝統的な建築様式：タケサル（木造土壁造）と1960年代に造られた学校、病院、公共施設等に集中した。タケサルは、耐震性のあるものとして、アドベ造にかわって奨励されていたが、断熱性を高めることを目的として、天井・屋根を厚くしていたため、これが落下し、多くの犠牲者を出した。さらに、火災が発生し、3日間にわたって延焼したため、5万戸以上が焼失し、震動被害と併せて、市内の75％が壊滅的に破壊された。

2　復旧と復興

地震後、かつてないほどの多量の海外援助がなされたが、被災住民の略奪によって、多くのスーパーマーケットや商店が襲われた。

マナグア地方は、1931年にも大きな地震災害を受け、それを教訓として、首都マナグア市は地震防災を考慮した計画的な市街地であった。しかし市街地は、1931年地震を発生させた断層が集中している地域に再建された。1972年の地震でも同様な断層が生じたため、マナグア市を従前の地区に再建すべきか、新しい地区に移転させるかの判断が遅れ、被災地区の復興は大幅に遅延した。



Managua City after the Earthquake (S Murakami and K Ito, "Earthquake and People", Dobun-shoin, 1984, pp 57)

1 The Earthquake and Resulting Damage

The epicentre was below Managua, the capital of Nicaragua. Three aftershocks (M=5.6) were observed in 40 minutes The central business district of the city is assumed to have been a part of the former Managua Lake, and it is located on ground which is piled up with volcanic dust and rock from volcanic activities Damage was limited to the area of complex ground conditions, with a radius of a few kilometres

Damaged buildings were primarily traditional ones, such as Dagesal(wooden structure with soiled walls) and schools, hospitals and public facilities built in the 1960s Dagesal had been recommended more than Adobe structures for earthquake resistance. However, the thick roofs and ceilings for insulation used in Dagesal structures fell during the earthquake, and increased the number of victims. Furthermore, fires broke out in the city and lasted for 3 days, burning 50,000 houses Together with the damage directly caused by the earthquake, 75 per cent of the city was severely damaged

2. Recovery and Reconstruction

Although enormous amounts of aid reached Nicaragua from overseas sources after the earthquake, victims broke into a number of local supermarkets and shops.

As the Managua region had been hit by a great earthquake in 1931, the built-up area of Managua city was planned and reconstructed to strengthen itself against earthquake However, the built-up area was still on the faultline which actually caused the earthquake in 1931 After the earthquake in 1972, similar faults were created in the city. The recovery activities were retarded in the stricken area because the government took too much time in deciding whether to relocate the city or to reconstruct the city where it had been before

A Damaged Dagesal Building (S Murakami and K.Ito, "Earthquake and People", Dobun-shoin, 1984, pp.57)