QUEENSLAND DEPARTMENT OF MINES

The Gatton earthquake of 15 August 1988

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GEOPHYSICAL SERVICES
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GATTON EARTHQUAKE OF AUGUST 15, 1988

by R.J. Cuthbertson

Introduction

On the morning of Monday 15th August, 1988, residents of the Lockyer Valley east of Brisbane were shaken by a moderate earthquake measuring 3.8 on the Richter scale. This report is a brief summary of the study undertaken by this Department to determine the effects of this earthquake on the local communities.

Epicentral Parameters

Data from the six seismographs in the Wivenhoe Dam network and the University of Queensland seismograph (BRS) at Mt. Nebo were used to locate the event 6 km east of Gatton at a depth of 9 km (Fig. 1). This location is almost directly beneath the Gatton Agricultural College.

The seismographs shown in Figure 1 were all overloaded by the earthquake and so amplitude measurements from these instruments could not be used for magnitude calculations. The seismograph at Boondooma Dam (Fig. 2) indicated that it had only just clipped and using the clipped amplitude gave a magnitude of ML 3.3. Magnitudes from BMR operated stations (Fig. 2) were -: Cobar ML 4.0 and Roma ML 3.7. The BMR seismograph at Cooney suffered a malfunction during the arrival of the seismic waves and a magnitude estimate could not be obtained. Based on these figures we have assigned a magnitude of ML 3.8 to the main shock.

Two aftershocks with magnitudes of ML 0.5 and -0.3 have also been located in the same area. The location of the magnitude 0.5 event on 15th August is within 1.5 km of the main shock. The event of 19th August has not as yet been accurately located. Table 1 is a list of epicentral parameters for the main shock and aftershocks.

Table 1 - Epicentral parameters of main shock and aftershocks

Date	Time	Latitude	Longitude	Depth (km)	Magnitude
15/8/88	9.23am	27.561	152.333	9.6	3.8
15/8/88	5.06pm	27.556	152.344	9.1	0.5
19/8/88	2.28am	------	-------	---	-0.3

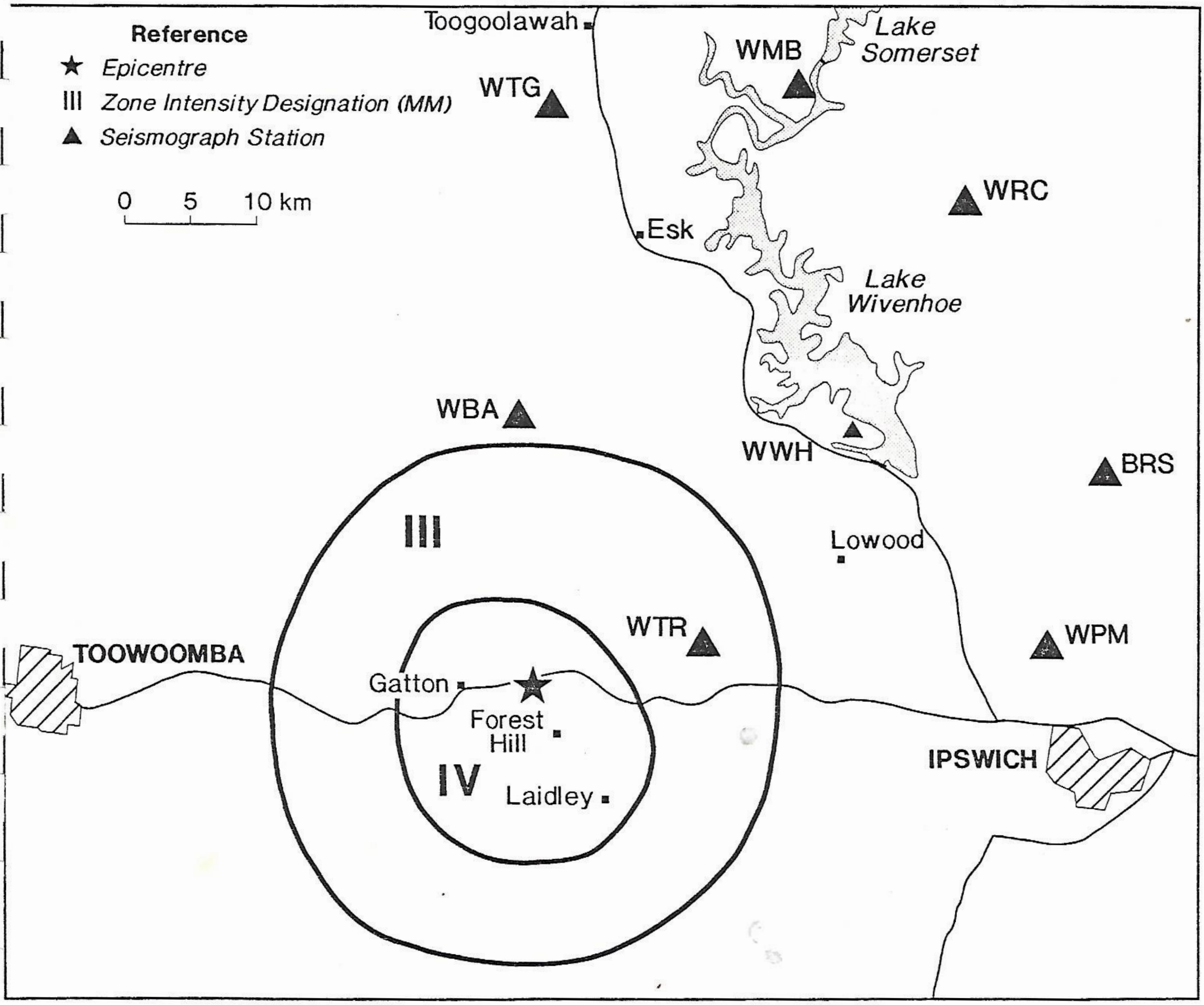

Fig. 1 -Seismographs in the Wivenhoe Dam network, and epicentre and isoseismal map of Gatton earthquake

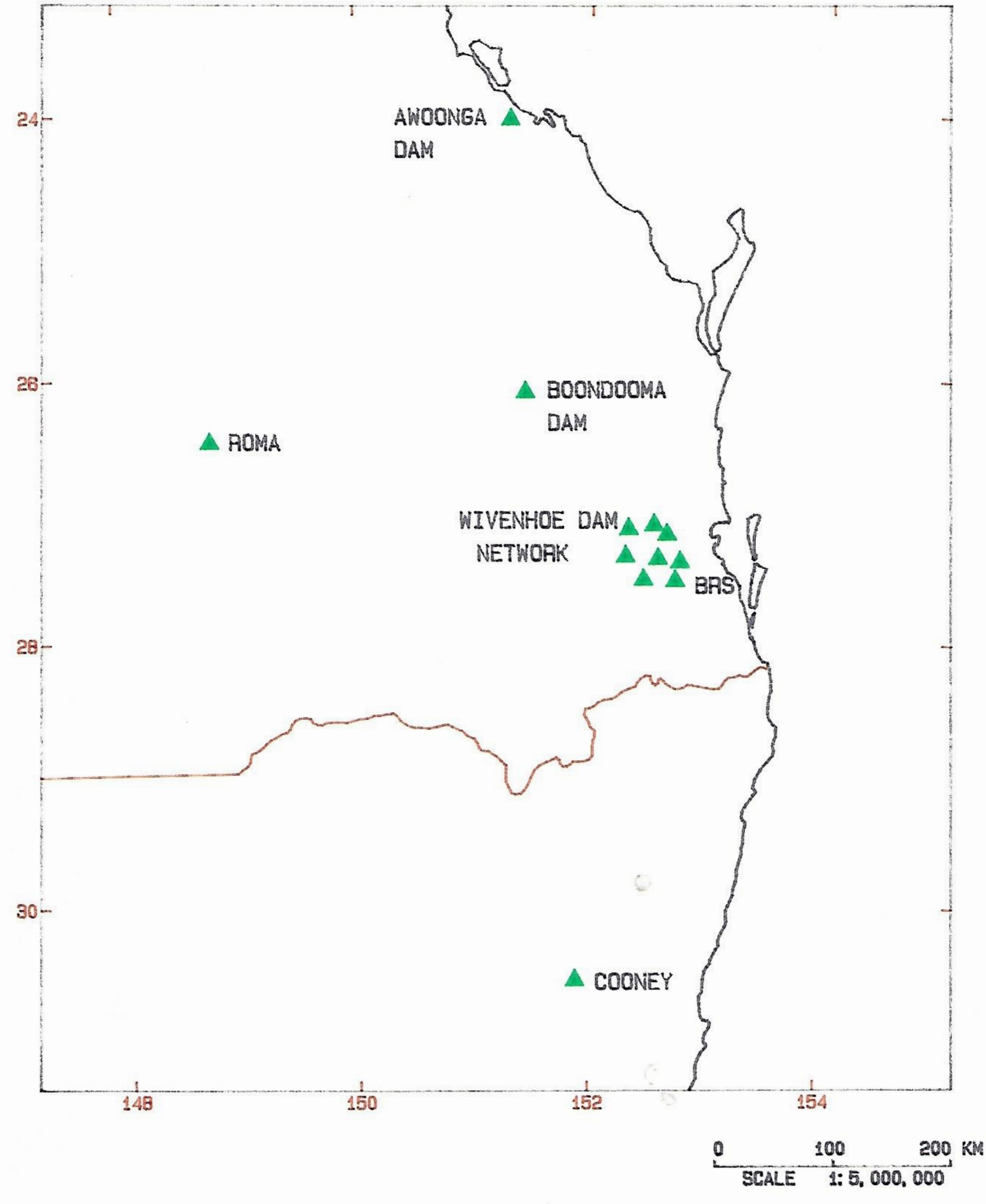

Fig. 2 - SEISMOGRAPHS IN SOUTHEAST QUEENSLAND AND NORTHERN NEW SOUTH WALES

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Table 2 - Modified Mercalli Intensity Scale
(NZ Version, 1965: NZ Journal of Geology and Geophysics Vol. 9)

MM 1	Not felt, except by people in especially favourable circumstances. Reported mainly from upper floors of buildings more than 10 stories high.
MM 2	Felt by people favourably placed (at rest, upstairs, reading, etc).
MM 3	Felt indoors, but may not be recognised as a tremor. Vibration like the passing of a light truck. Hanging objects swing. Duration by be estimated.
MM 4	Generally noticed indoors. Very light sleepers wakened. Vibration like heavy traffic or an object striking the building. House frames creak. Doors, windows, glassware and crockery rattles.
MM 5	Generally felt outside and by almost everyone inside. Most sleepers wakened and a few people frightened. Direction estimated. Small unstable objects displaced or upset. Some windows cracked. Some glassware and crockery may be broken. Hanging pictures move. Doors and shutters may swing. A few earthenware toilet fixtures cracked. Pendulum clocks start and stop.
MM 6	Felt by all. Many run outside. Difficulty experienced in walking. Slight damage to Masonry D. Some plaster cracks. Isolated chimney damage. Windows, glassware and crockery broken. Objects fall from shelves and walls. Heavy furniture moved. Unstable furniture overturned. Small bells ring. Trees and bushes shake. Material may be dislodged from existing slips.
MM 7	General alarm. Difficulty in standing. Noticed by drivers or motorcars. Trees and bushes strongly shaken. Large bells ring. Brickwork dislodged, walls cracked, chimneys broken and water tanks burst.
MM 8	Alarm may approach panic. Steering of cars affected.
MM 9	General panic. Damage to paths and roadways. Underground pipes broken.
MM 10	Most masonry structures destroyed. Railway lines slightly bent. Seiches and large landslides.
MM 11	Wooden frame structures destroyed. Great damage to railway line and pipes.
MM 12	Damage virtually total. Objects thrown into air. Large rock masses displaced.

Felt Effects

A survey by this Department has produced the map (Fig. 1) which indicates the effects of the main shock on the Modified Mercalli Intensity Scale at various localities (see Table 2 for a description of the Modified Mercalli Scale). The outer circle (MM III) depicts the extent over which the tremor was felt. There have been isolated reports from a much larger area, including Ravensbourne, Lowood and even some from Brisbane, but these were generally from people who were in a favourable position to feel the vibrations. The inner circle (MM IV) indicates the area of higher intensities. Inside this area there were isolated instances of minor damage to houses including cracked brickwork, tiles and plaster. These are classified as MM V or MM VI but they were not considered representative of the intensity in the epicentral area and so an MM V isoseismal line was not drawn.

Reservoir Induced Seismicity

Research into the phenomenon of reservoir induced seismicity has found that induced activity generally consists of numerous foreshocks and aftershocks at a shallow (<5 km) focal depth. Activity generally commences within several months of filling within 25 km of the reservoir, with most of the activity in the immediate vicinity of the reservoir.

Seismic activity recorded since the Wivenhoe Dam network was installed in 1977 is shown in Figure 3. The current configuration of seismographs is also shown along with the "area of interest". Any seismic activity induced by the filling of the reservoir will almost certainly occur within this area. The occurrence of this event at Gatton within 1 month of the reservoir reaching FSL has led some people to assume it was induced by the increase in water level. The distance (over 30 km) from Wivenhoe Dam, the lack of any unusual foreshock or aftershock activity, and the relatively deep focus all indicate that this event is simply a continuation of the natural seismicity already detected in the area and is not associated in any way with the filling of the reservoir. Similar events that have occurred in the area in the past ten years were at Esk in 1978 (magnitude 3.8), Tenthill in 1981 (magnitude 2.6) and Somerset Dam in 1986 (magnitude 2.6).

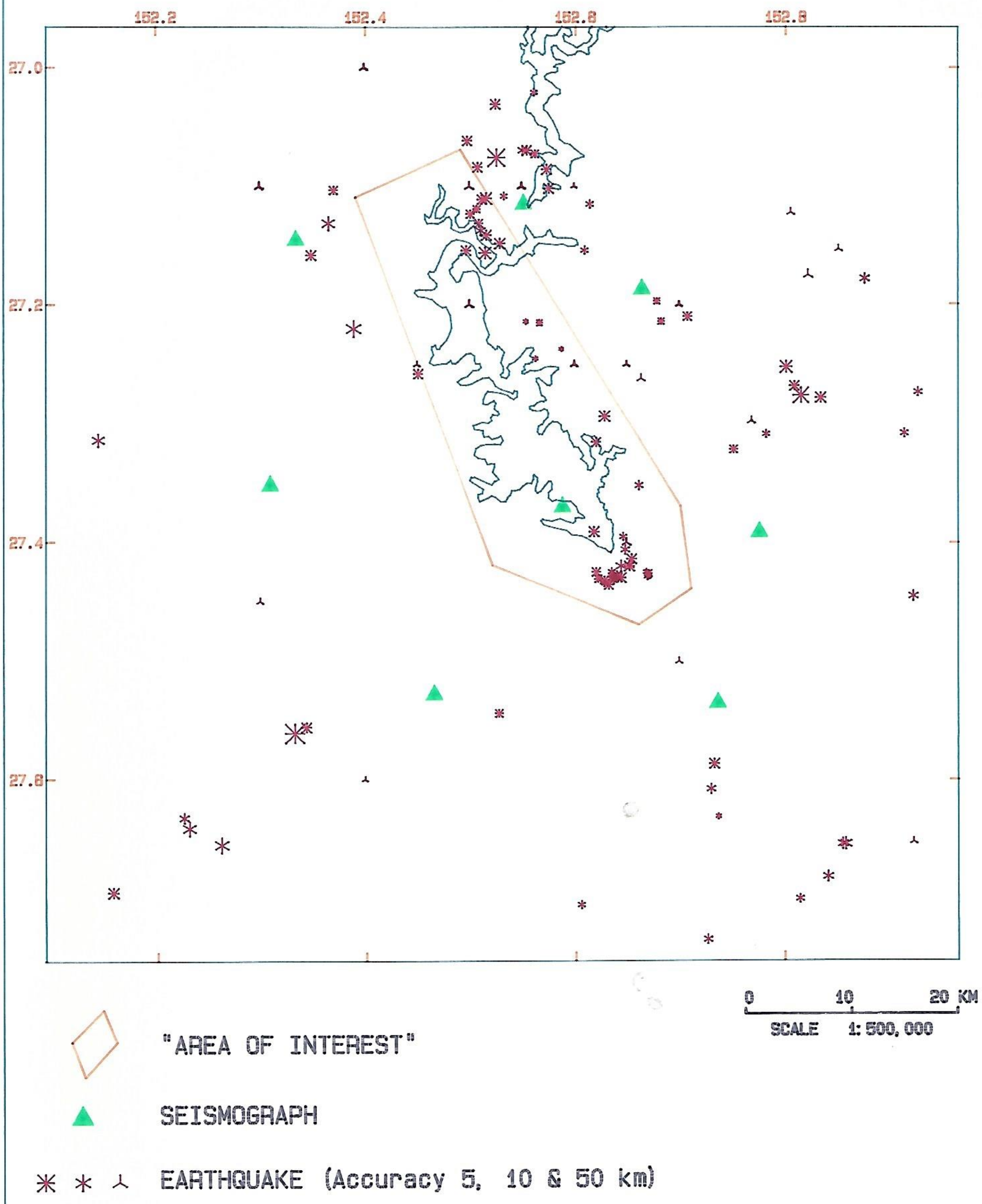

Fig. 3 - EARTHQUAKE LOCATIONS IN THE WIVENHOE DAM REGION

SINCE APRIL 1977

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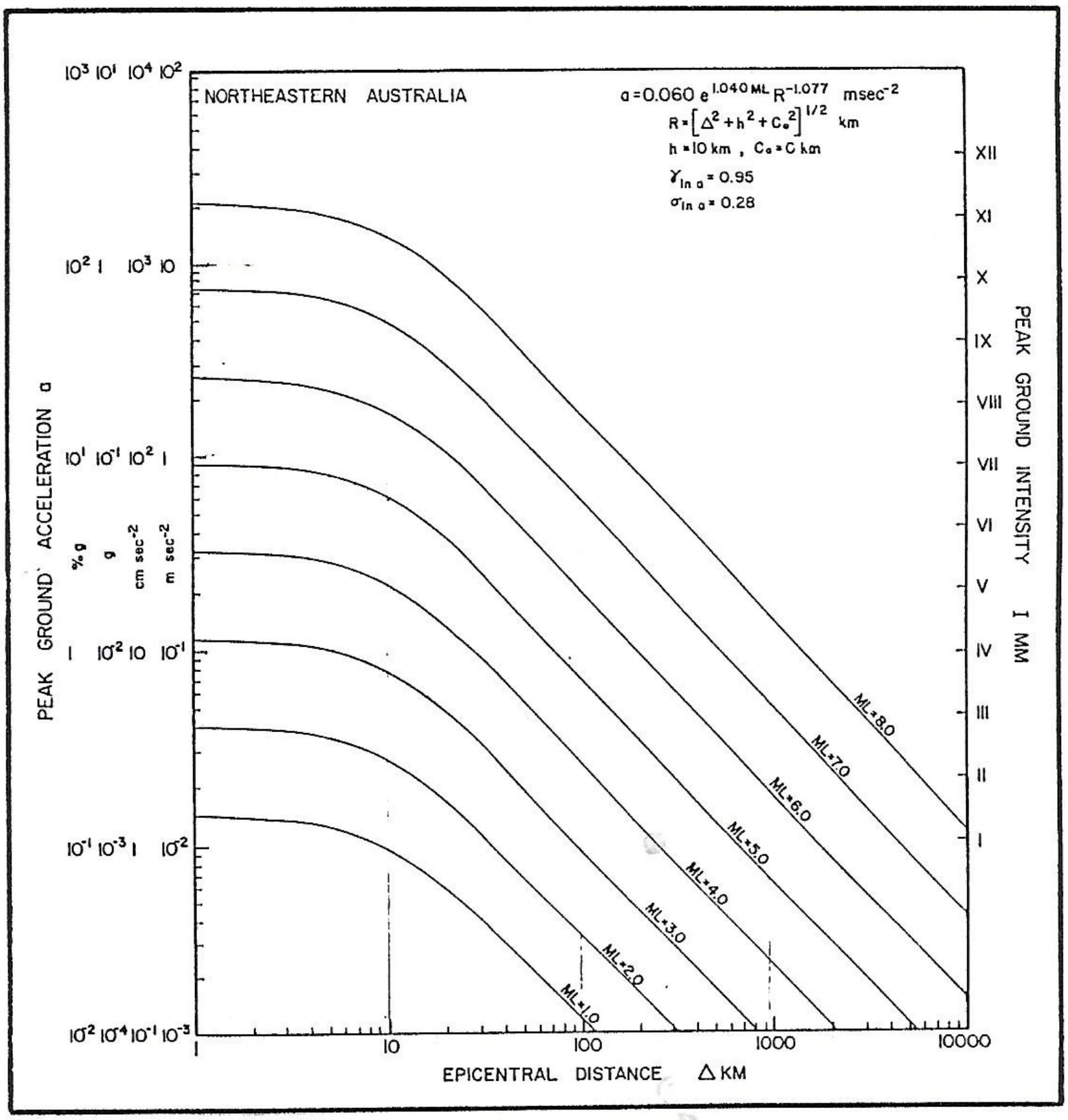

Fig. 4 -Attenuation relationships for northeastern Australia
(From Rynn, J.M.W., 1987, Queensland Seismic Risk Study, Final Report to the Queensland Government)

Strong Motion Instrumentation

Six accelerographs were purchased in 1985 to monitor strong motions of structures in the Wivenhoe Dam complex in the event of a large nearby earthquake. These recorders are located at the base and crest of both Wivenhoe and Splityard Creek dams and inside and outside of the Wivenhoe Power Station. These digital recorders have a preset acceleration threshold trigger and a delay memory to capture seismic signals prior to the threshold level.

As well as monitoring accelerations on the various structures this instrumentation can also play an important role in obtaining better estimates of attenuation for seismic risk analysis. The formula which relate the variation of acceleration with distance away from an epicentre (Fig. 4) is based on intensity data, not acceleration data. A second formula that relates intensity to acceleration is used to convert the intensity-distance relationship to an acceleration-distance relationship. It would be much more reliable to obtain the acceleration-distance relationship directly from acceleration measurements of earthquakes. Unfortunately there are no acceleration readings for north-east Australia to aid in better estimating seismic risk.

Application of the formula relating acceleration to distance (Fig. 4) indicates that at a distance of 36 km from a magnitude 3.8 earthquake the acceleration should be 0.007g. The intensity-acceleration relationship indicates that intensity MM III corresponds to accelerations of 0.005g. This earthquake was not generally felt in the vicinity of the Dams which indicates that the intensity was less than MM III and therefore the acceleration was below 0.005g. Both of the above relationships are based on intensity data that is inherently qualitative and so they can only be used as an approximation.

Problems with the instrumentation at the time of this earthquake meant that the recorders on the base and crest of Wivenhoe Dam and on the crest of Splityard Creek Dam were out of commission.

The threshold levels for the operating instruments are 0.006g for the recorders in the Power Station carpark and at the base of Splityard Creek Dam, and 0.050g for the recorder inside the Power Station. None of these recorders triggered on this event which indicates that if they were functioning properly the acceleration level at both the Power Station and Splityard Creek Dam was below 0.006g.

Conclusions

The magnitude 3.8 earthquake at Gatton on 15th August, 1988 was felt within a 25 km radius. The distance of this earthquake from the reservoir, the lack of a significant foreshock/aftershock sequence and the relatively deep focus all suggest this event was not reservoir induced. It is coincidental that the earthquake occurred within 1 month of the filling of Wivenhoe Dam.

The failure of the accelerographs associated with the Wivenhoe Dam complex to trigger indicated that the acceleration levels in the Dam area were below 0.006g. This value is similar to accelerations expected using acceleration-distance or intensity-acceleration formulae.