United Kingdom Atomic Energy Authority

AWRE, Aldermaston

AWRE REPORT No. 033/70

Some Seismic Results of the MEDEO Explosions in the Alma Ata Region of the USSR

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This report is Shot Report No. 2.

C1

550.34:W91.54
W91.54:550.34

FOREWORD

During the course of a speech to the United Nations on 5th December 1968, Ambassador William C. Foster, United States representative in Committee I on disarmament, made the following statement.

"As demonstrated by activities such as these, the United States is continuing to devote considerable resources to seismic research so as to improve the capability to detect and identify underground seismic events. However, it is a fact that, with the existing technology, we are unable to gather all available seismic data at long distances. We are unable at such distances to detect or locate accurately all seismic events or to identify positively whether certain seismic signals come from earthquakes or man-made explosions.

Fortunately, there is clearly a widespread desire - fully shared by the United States - for further advancement in seismic technology and for increased international exchange of information in this field.

It is in keeping with this desire that I should like to present today a proposal which the United States considers could do much to advance objectives in these areas. The United States proposes that some underground nuclear explosions be conducted with the collateral objective that these serve as explosions for worldwide seismic investigation. This investigation is one in which all States with the appropriate seismic instrumentation could participate. Indeed, the success of this proposal would depend in large measure on the extent of worldwide participation in the collection and evaluation of the seismic data."

One form of the United Kingdom contribution of the investigations will be Shot Reports which present the principal data recorded by the 4 seismological array station sponsored by the UK Atomic Energy Authority and operated with the co-operation of the Dominion Observatory, Canada, the Bhabba Institute for Atomic Research, Trombay, and the Australian National University, Canberra.

As the opportunity occurs, the Shot Reports will be used to summarise data recorded from any interesting explosions on which full details of location, depth, and yield are accessible.

The Longshot report (AWRE Report 067/66, HMSO, October 1966) now constitutes Shot Report No. 1. The MEDEO chemical explosions in the Alma Ata region are reported here as Shot Report No. 2. Gasbuggy and Rulison, two of the USA Plowshare trials, are in preparation for Shot Report No. 3.

K.D. Bomford,
Chief of Applied Physics

SUMMARY

On the 21st October 1966 two large TNT explosions known as the MEDEO explosions were detonated underground in the Alma Ata region of the USSR. Both explosions were recorded by the four UKAEA sponsored seismic array stations. The analysis of these data and the shot details are reported.

1. SHOT DETAILS

The shot details are taken from a translation of a Russian report on these two explosions [1].

Code name: MEDEO

The shot coordinates and firing time:

77°03'39"E
43°09'14"N

21st October 1966 045959.1 GMT

(1) Auxiliary charge 1.689 kton.

(2) Main charge 3.604 kton.

2. RUSSIAN SEISMIC OBSERVATIONS

An abbreviated translation of the original report on these two explosions [1] dealing with the Russian instrumental seismic observations is given in a Geosciences and Technology Bulletin [2] and for convenience is reproduced here.

"The city of Alma Ata is located on the alluvial fan of the Malaya Almaatinka river. Once every 50 - 100 years it is flooded by catastrophic mud flows. In order to eliminate the danger of future mud flows, it was decided to construct a dam across the valley of the Malaya Almaatinka river by means of directed explosions.

Two rows of charges were emplaced in shafts dug out in granite forming the right bank of the Almaatinka river. The arrangement of charges is shown in figure 1. Detonation of the first row of four auxiliary charges (Nos. 7 to 10 in figure 1) would eliminate the convexity of the bank and form a cavity needed for proper rock ejection by the directed explosion of the main charge (No. 6). The exact coordinates of the explosion site are 77°03'39"E longitude and 43°09'14"N latitude. The explosives consisted mainly of TNT. The 3604 ton main charge required excavation of an explosion chamber with a volume of 4680 m^3. A 150 m long gallery led to the chamber of the main charge.

The charges of the first series of explosions were set off on 21st October 1966. Auxiliary charges Nos. 7 to 9 were detonated at 045959.1 GMT. In view of the unfavourable location of auxiliary charge No. 10, its location being such as to result in possible ejection toward the gorge, it was exploded with a 50 ms delay. It was expected that the delay would result in rock ejection toward the common centre of the dam. The total weight of auxiliary charges (Nos. 6 to 10) was 1689 tons. The main charge (No. 6), with a weight of 3604 tons, was set off 3.56 s (the translation gives 3.56 ms, this is obviously an error) after the detonation of the auxiliary charges at 050002.7 GMT . "The magnitude m was determined only for the second explosion. Using records from 10 (Russian) stations at distances between 600 and 4000 km from the test site, it was determined that $m_b = 5.1 \pm 0.2$. For the same explosion it was determined that $M_s = 3.7 \pm 0.2$." (Magnitudes are quoted for the second larger explosion.)

3. UKAEA SPONSORED ARRAY RESULTS

Four linear arrays of AWRE design [3] were operating at the time of these explosions.

Eskdalemuir, Scotland	EKA	55°19'59.0"N	03°09'33.0"W
Yellowknife, Canada	YKA	62°29'34.3"N	114°36'16.5"W
Gauribidanur, India	GBA	13°36'15.0"N	77°26'10.0"E
Warramunga, Australia	WRA	19°56'32.8"S	134°21'15.8"E

The short period P wave signals were recorded at all four arrays. Long period surface waves were not recorded at Eskdalemuir or Yellowknife, the other two arrays were not operating long period recorders.

The processed [3] array records from each array are shown in figure 2. The P wave onset pulses from the two explosions are clearly seen, on all four seismograms, separated by 3½ s. The arrival times of the first P wave onset and the amplitudes of the P waves from the two explosions are given in table 1.

TABLE 1

Summary of P Wave Observations from MEDEO at UKAEA Sponsored Array Stations

Station	Distance, Δ°	Arrival Time, GMT	Shot 1 (1.689 kton Chemical) m_b	Shot 2 (3.604 kton Chemical) m_b	Shot 2 USSR Station, Mean m_b
EKA	50.9	05 0901.6	4.97	5.22	
YKA	74.3	05 1136.9	4.89	5.18	
GBA	29.4	05 0603.7	4.38	4.58	
WRA	81.9	05 1219.4	4.47	4.81	
		Mean	4.68	4.95	5.1

4. EPICENTRE LOCATION

It is intended that these reports should summarise the seismic data recorded only at the four array stations. The arrival times of P waves at a larger number of stations would normally be used to locate the epicentre of an event. The accuracy of the location would depend on a number of factors such as the distribution of stations as a function of azimuth around the epicentre and the number of stations for which P wave arrival time data are available. Of these, the former is the more important.

The P wave arrival time data at the four array stations can be used to locate epicentres, but the azimuthal coverage may not always be satisfactory for accurate location. Nevertheless, for the sake of completeness in these reports, when 3 or 4 of the arrays have recorded the P onset, an epicentre will be estimated with the depth restrained to zero.

In the case of the MEDEO explosion EKA and YKA are to the north and WRA and GBA are to the south of the event giving poor E-W coverage. The epicentre determined is given in table 2. The error in location is 7.6 km in a direction 301° E of N.

TABLE 2

Epicentre Location from 4 Array P Wave Arrival Time Data

	Estimated Epicentre	True Epicentre	
	43.11° N ± 0.16° 77.14° E ± 0.16°	43.15° N 77.06° E	
Origin Time	045956.8	045959.1	GMT

5. ACKNOWLEDGMENTS

The recordings at the overseas stations were made possible by the cooperation of the Dominion Observatory, Ottawa, Canada; the Bhabha Institute for Atomic Research, Trombay, India; and the Australian National University, Canberra, Australia.

REFERENCES

1. F.F. Aptikayev et al.: "The Results of Scientific Observations during the MEDEO Explosion". AN KazSSR Vestnik, 5, 30-40 (1967)

2. Geosciences and Technology Bulletin, 3, 3, Aerospace Technology Division, Library of Congress

3. C.G. Keen et al.: "British Seismometer Array Recording Systems". Radio and Electronic Engineer, 30, 5 (November 1965)

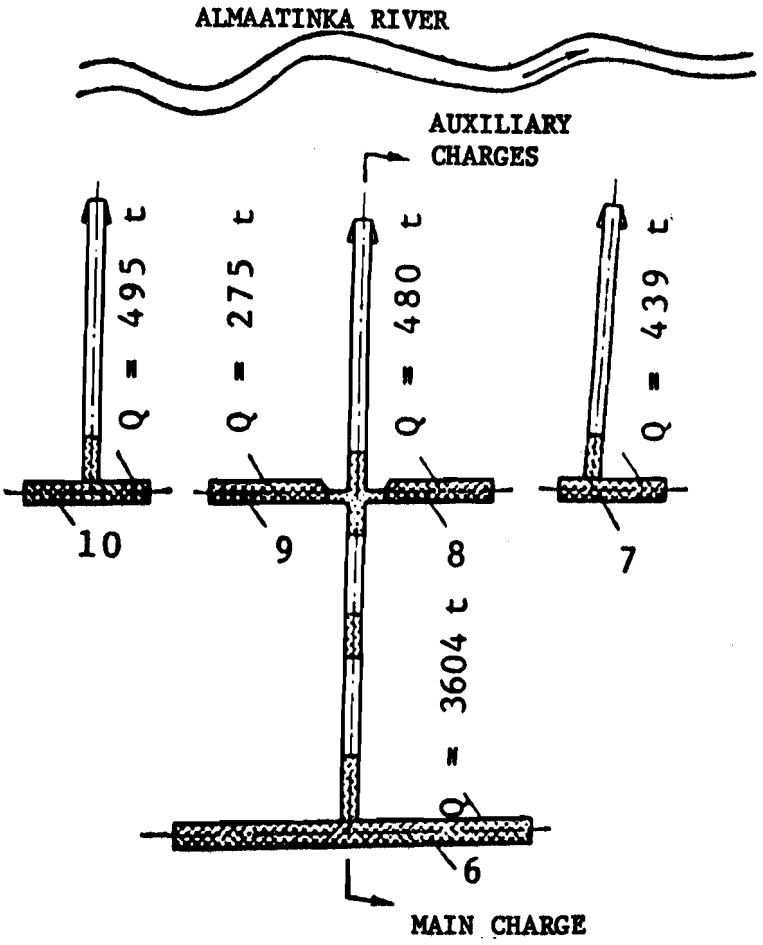

FIGURE 1. ARRANGEMENT OF CHARGES AND THEIR WEIGHTS

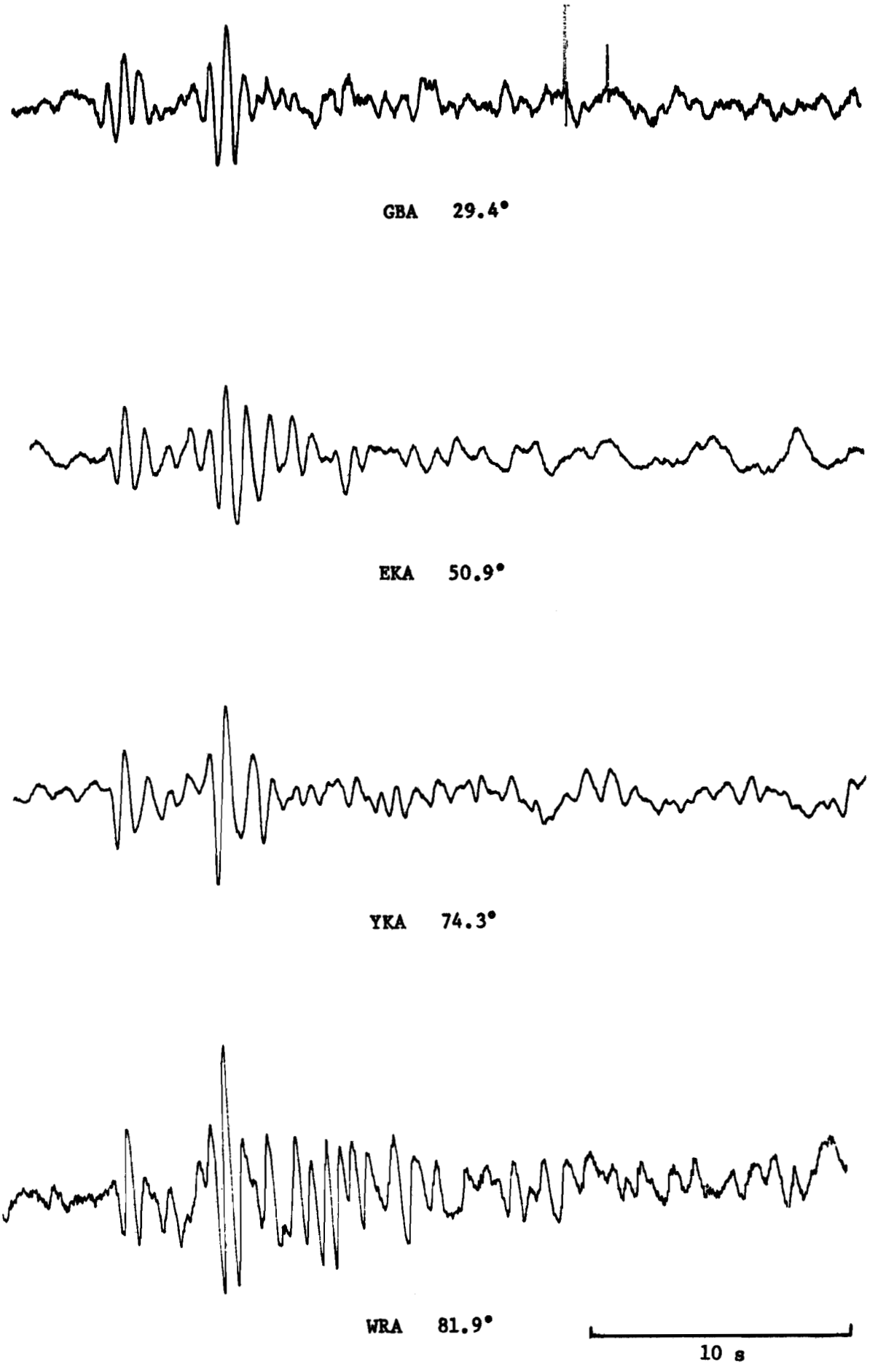

FIGURE 2. PROCESSED SUM-ALL RECORD, UNFILTERED FROM THE FOUR UKAEA SPONSORED ARRAYS