United States Department of the Interior
Geological Survey

Louisiana Barrier-Island Erosion Study
Isles Dernieres Beach Profiles--September 1987 through September 1988

by
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ABSTRACT

As part of the Louisiana Barrier-Island Erosion Study, scientists from the U. S. Geological Survey selected a section of the Isles Dernieres barrier-island arc for a detailed, multi-year study. The main objective of this study is to determine the nature of the local morphodynamic processes that have produced substantial erosion and northward migration of the Gulf of Mexico side of islands during, at least, the last 100 years. One of the elements of the study is a beach-profiling program using a highly accurate electronic distance meter (EDM). Eleven shore-normal lines spaced along 400 m of the island were surveyed six times during the period of September 1987 through September 1988 to determine the time and extent of beach change during a time when the area was eroded by both cold fronts and hurricanes.

Between September 1987 and July 1988, a period within which multiple cold fronts crossed the area, the beach face retreated an average of 17 m within the study area. More than 80% of that erosion occurred between the 20 September 1987 and 6 March 1988 surveys. The volumetric loss of material from the beach face and inner surfzone was approximately 18,400 m^3, but only about 400 m^3 of that material was deposited on the backshore.

In September 1988, two hurricanes--Florence and Gilbert--affected the study site. A field team conducted an abbreviated, non-EDM survey between the two hurricanes, and a complete survey after Hurricane Gilbert. Between the July and second September surveys, the average beach-face retreat decreased from about 40 m at the berm crest to only about 10 m at mean sea level (MSL). Along the center line, which was the only one where pre-hurricane surveys started far enough shoreward to accurately measure the changes, all of the material removed from the beach face was deposited on the backshore.

INTRODUCTION

The Louisiana coastline is subject to two major erosional forces: cold fronts that cross the area every five-to-ten days during the winter, and hurricanes that occasionally move through the Gulf of Mexico. Both produce storm waves that attack the beach face and can raise sea level enough to produce overwash. Field research on the dynamics of overwash for the Louisiana Barrier-Island Erosion Study commenced in August 1986 at a centrally-located site on the Isles Dernieres (Fig. 1). Since that time, researchers have visited the site 12 times to profile a 400-m stretch of beach along 11 shore-normal lines (Fig. 2). Dingler and Reiss (1988) present the cross-shore profile data collected during the first year of the study. Because that report contains a discussion of the erosional problems of the Isles Dernieres barrier-island arc and a detailed description of the site and surveying techniques, this report will primarily discuss the profiles from the second year.

During the first year of the study, cold fronts caused an average of 20 m of beach-face retreat at mean sea level (MSL) and a net loss of material of almost 14,000 m^3 of material. There were no hurricanes during that year. During the second year, cold fronts were again active throughout the winter. Then in September 1988 two hurricanes impacted the Isles Dernieres, although neither of them crossed those islands.

CROSS-SHORE PROFILES

A field team surveyed the eleven cross-shore lines six times between 20 September 1987 and 28 September 1988 using an EDM (Table 1), and 3 lines (W5, CL, and E5) on 14 September 1988 using standard leveling techniques. Profiles from the six surveys listed in Table 1 are shown in Figures 3 through 5; each figure contains profiles from two dates for clarity. To show changes between surveys, center-line profiles are grouped together on Figures 6 and 7.

Table 1. Dates for Cross-shore Surveys at the Isles Dernieres Study Site

19-20 September 1987
8 December 1987
6 March 1988
11 May 1988
15-16 July 1988
28 September 1988

To determine the net amount of erosion during a year, the profiles were redigitized at one-meter intervals and the change in volume between pairs calculated. Figure 8 shows the volumetric change between the September 1987 and July 1988 surveys, a time period that included a cold-front season and a subsequent, low-energy period; Figure 9 shows the changes between the July 1988 and September 1988 surveys, a time period that included both hurricanes. In both figures the data is presented in two ways. The solid line represents the difference in elevation at each meter along the profile; the dashed line is a cumulative total of those differences starting at the onshore end of the profile. Wherever the cumulative curve crosses zero, the net change in volume is zero shoreward of that point.

DISCUSSION OF RESULTS

1987-88 Cold-Front Season

Dingler and Reiss (in press) show that the sediment removed from the beach face during the winter, cold-front season of 1986-87 did not return the next summer. Therefore, the approximately 20 m of beach-face retreat remained until the next cold-front season. The average beach-face retreat between the September 1987 and July 1988 surveys was 17 m as measured at MSL. Most of this erosion occurred between the September 1987 and December 1987 surveys. The total volumetric loss from the study area between the September 1987 and July 1988 surveys was 18,000 m^3, with 18,400 m^3

removed from the beach face and 400 m^3 deposited on the backshore. Thus, the total amount of material eroded from the beach face was about the same as that removed the previous year (19,200 m^3), the amount deposited on the backshore was significantly less (400 m^3 vs. 5,600m^3). Some of the difference in backshore deposition might be explained by the eolian transfer of material to small dunes, because dune growth seemed, visually, to be much greater during the second year.

During the month of September 1988, two hurricanes entered the Gulf of Mexico. Although neither of them hit land in Louisiana, the waves and storm tides generated by each reached the Isles Dernieres. The abbreviated survey made after Hurricane Florence, which was a small hurricane that hit land on the northern Gulf coast of Florida, showed little change from the previous survey. However, the survey after Hurricane Gilbert, an extremely powerful hurricane that struck eastern Mexico after travelling along an east-to-west path south of the Isles Dernieres, showed extreme erosional changes. Although beach-face retreat at MSL was only 10 meters, berm-crest retreat was over 40 m. Comparing the pre- and post-hurricane profiles for the center line showed an increase in sediment of about 7 m^3 per m of beach width and that essentially all of the sediment eroded from the beach face was deposited on the backshore. Although not as detailed as the normal surveys, the profiles after Hurricane Florence indicated that essentially all of the change could be attributed to Hurricane Gilbert.

Both processes--cold fronts and hurricanes--produced extensive beach-face erosion. The major differences in profile change caused by the cold fronts and by Hurricane Gilbert were the differential beach-face erosion and the high percentage of backshore deposition caused by the latter. After the cold-front season, most of the material eroded from the beach face could not be found in the surveyed area; after Hurricane Gilbert, almost all of the material was deposited on the backshore. One possibility is that the difference in depositional patterns was due to differences in water depth during the two processes. Cold fronts generally elevate the local water level to, or slightly above, the elevation of the berm crest. Therefore, very little material is carried onto the backshore. Also, the waves generated by the cold fronts attack the entire beach face. Because the lower part of the beach face is muddy (Dingler and Reiss, 1988; Dingler and Reiss, in press), those waves erode mud, which currents then move to deep water. The waves from Hurricane Gilbert, on the other hand, appeared to attack primarily the upper beach face, probably because sea level had been elevated several meters above normal. Therefore, the waves from Hurricane Gilbert only eroded sand, and that sand could be transferred to the backshore because of the water depth.

CONCLUSIONS

Beach profiles taken at a study site on the Isles Dernieres between September 1987 and September 1988 document the nature of two forces that cause beach erosion. Between September 1987 and May 1988, cold fronts caused about 17 m of beach-face retreat with substantial beach-face erosion and inconsequential backshore deposition. Between May 1988 and July 1988, no beach-face recovery was observed. In September 1988, Hurricane Gilbert caused over 40 m of berm-crest retreat; however, all of the sediment removed from the beach face was deposited on the backshore.

REFERENCES

Dingler, J. R. and Reiss, T. E., 1988, Louisiana Barrier-Island Erosion Study: Isles Dernieres Beach Profiles--August 1986 to September 1987: U. S. Geological Survey, Open-File Report 88-7, 27 p.

Dingler, J. R. and Reiss, T. E., in press, Short-term migration on the Isles Dernieres, a barrier-island arc along the central Louisiana coast: Marine Geology.

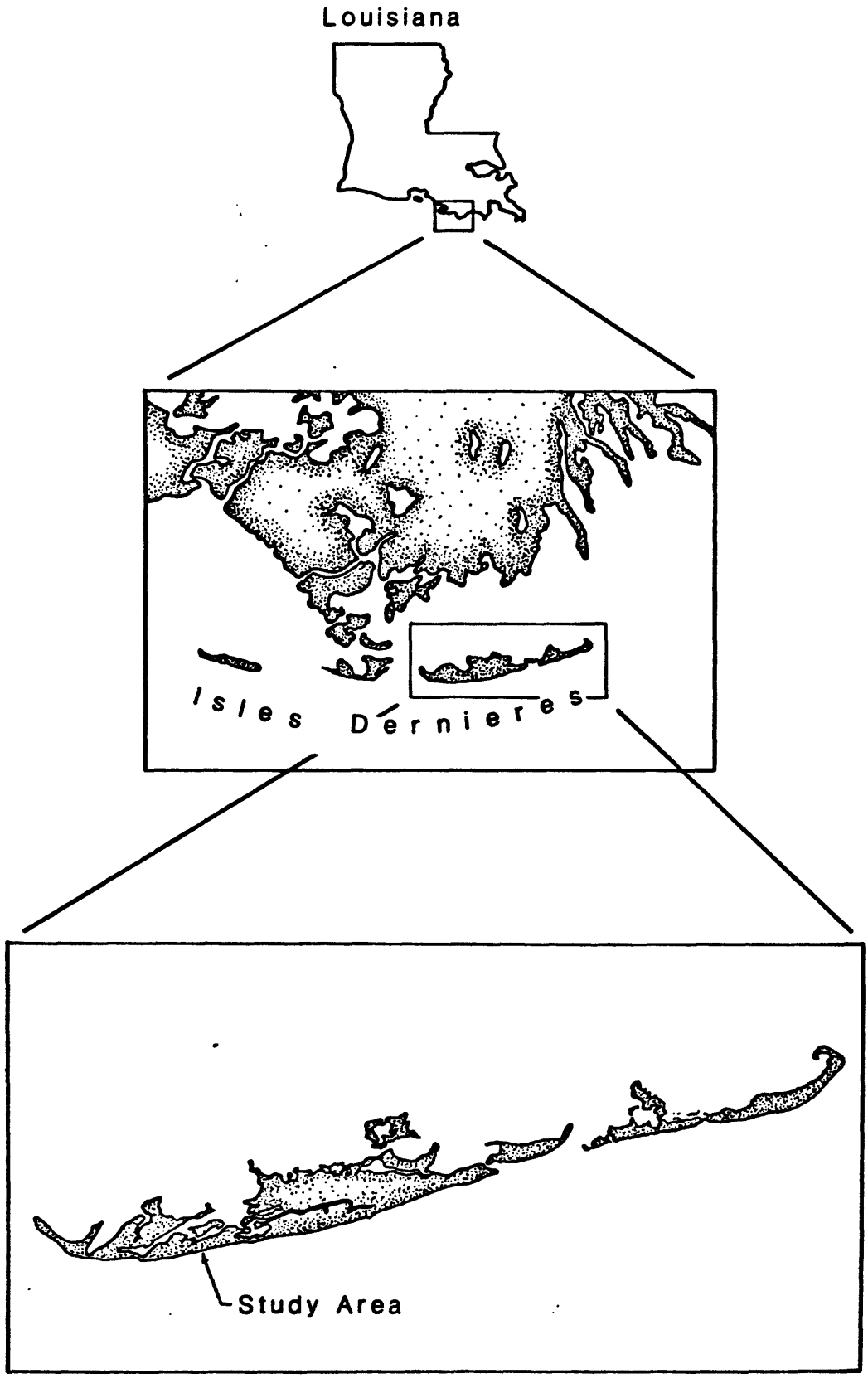


Figure 1. Isles Dernieres, central coast of Louisiana, showing location of study area.

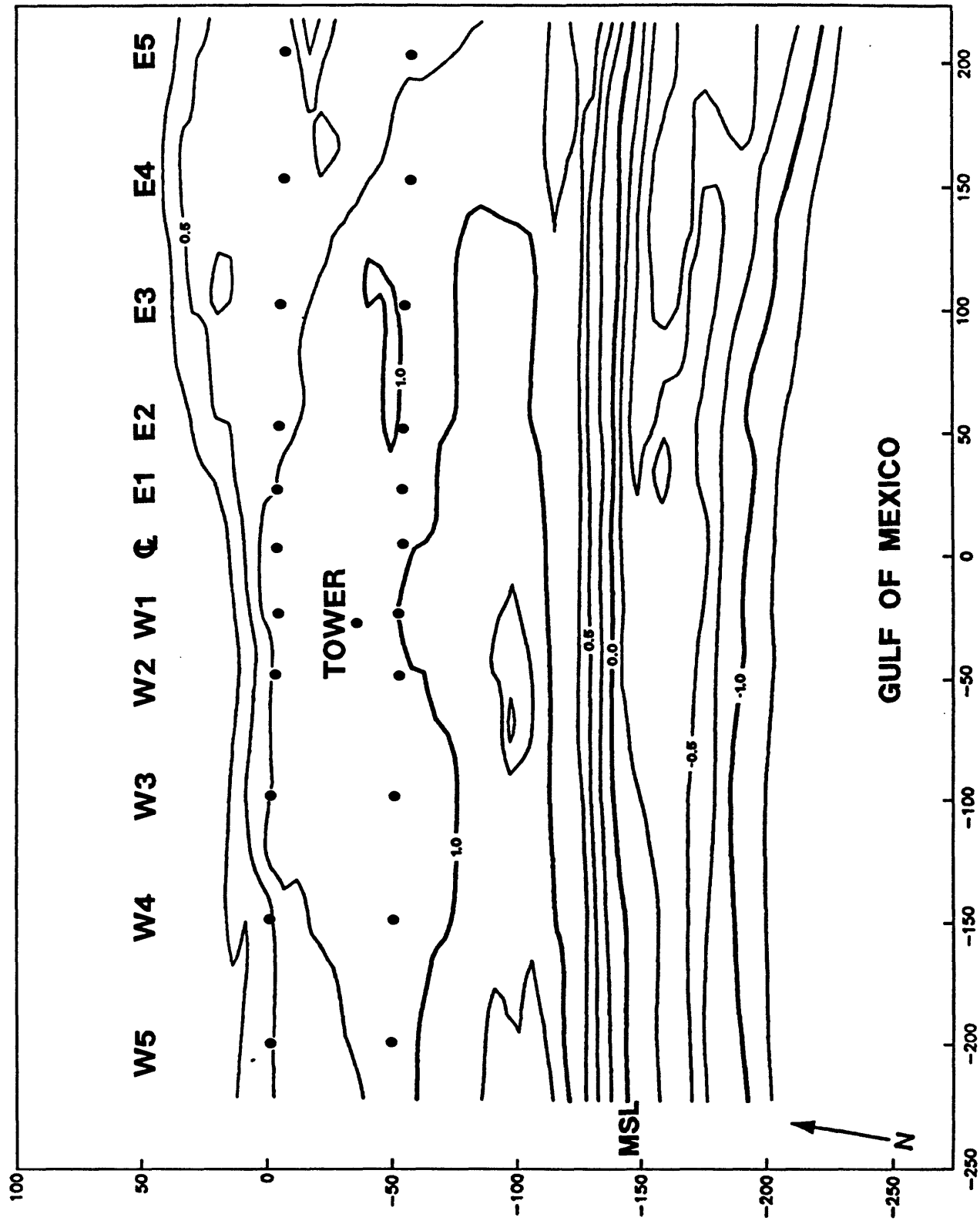


Figure 2. Contour map of study area drawn from surveys made in August 1986. Dots locate reference stakes for 11 shore-normal lines and data-transmission tower. Contour interval, 0.25 m; axes scales in meters. Zero contour is at mean sea level (MSL).

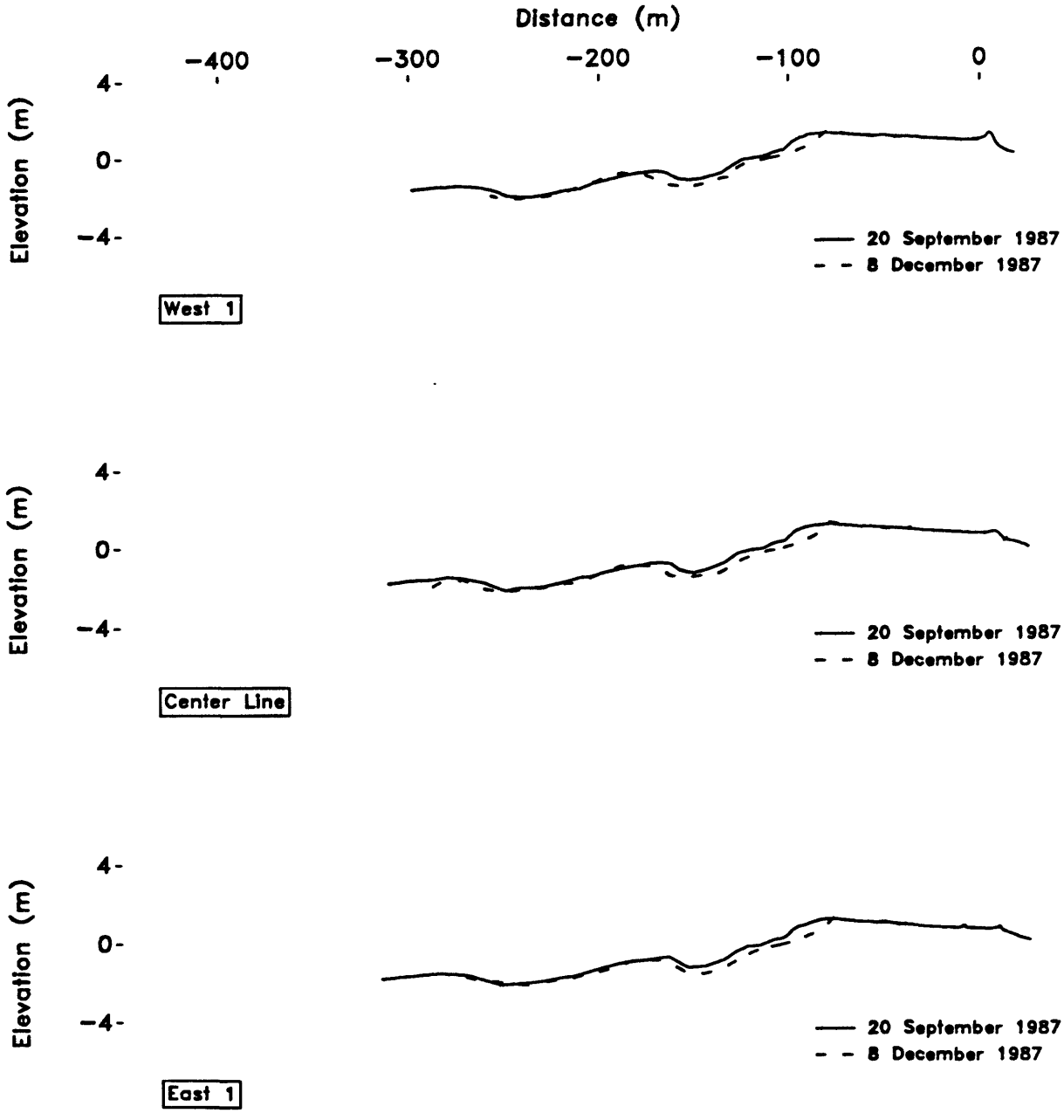
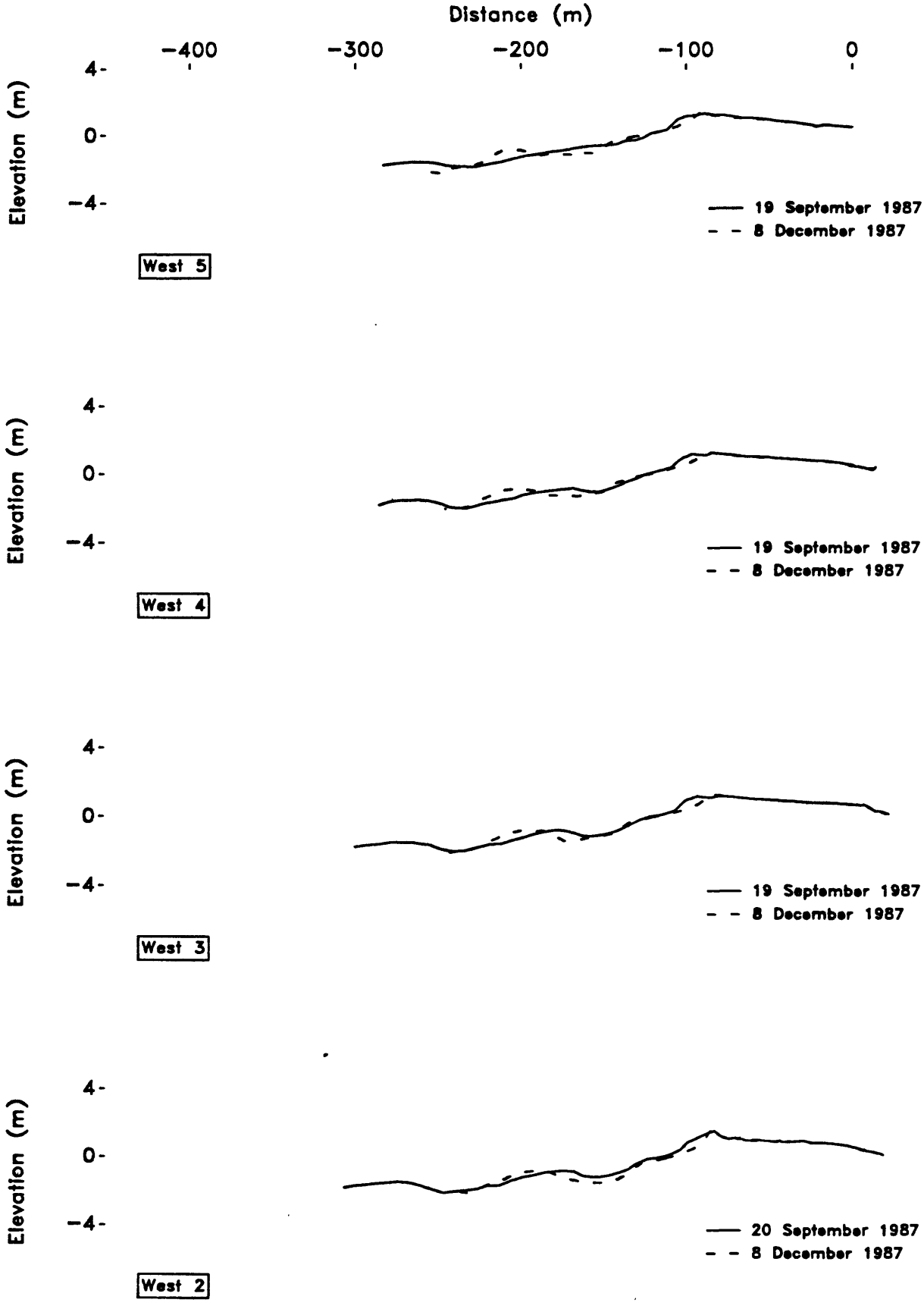


Figure 3. (Page 1 of 3) Eleven profiles from the September and December 1987 surveys. The profiles appear on three pages. Vertical exaggeration is 10 times.



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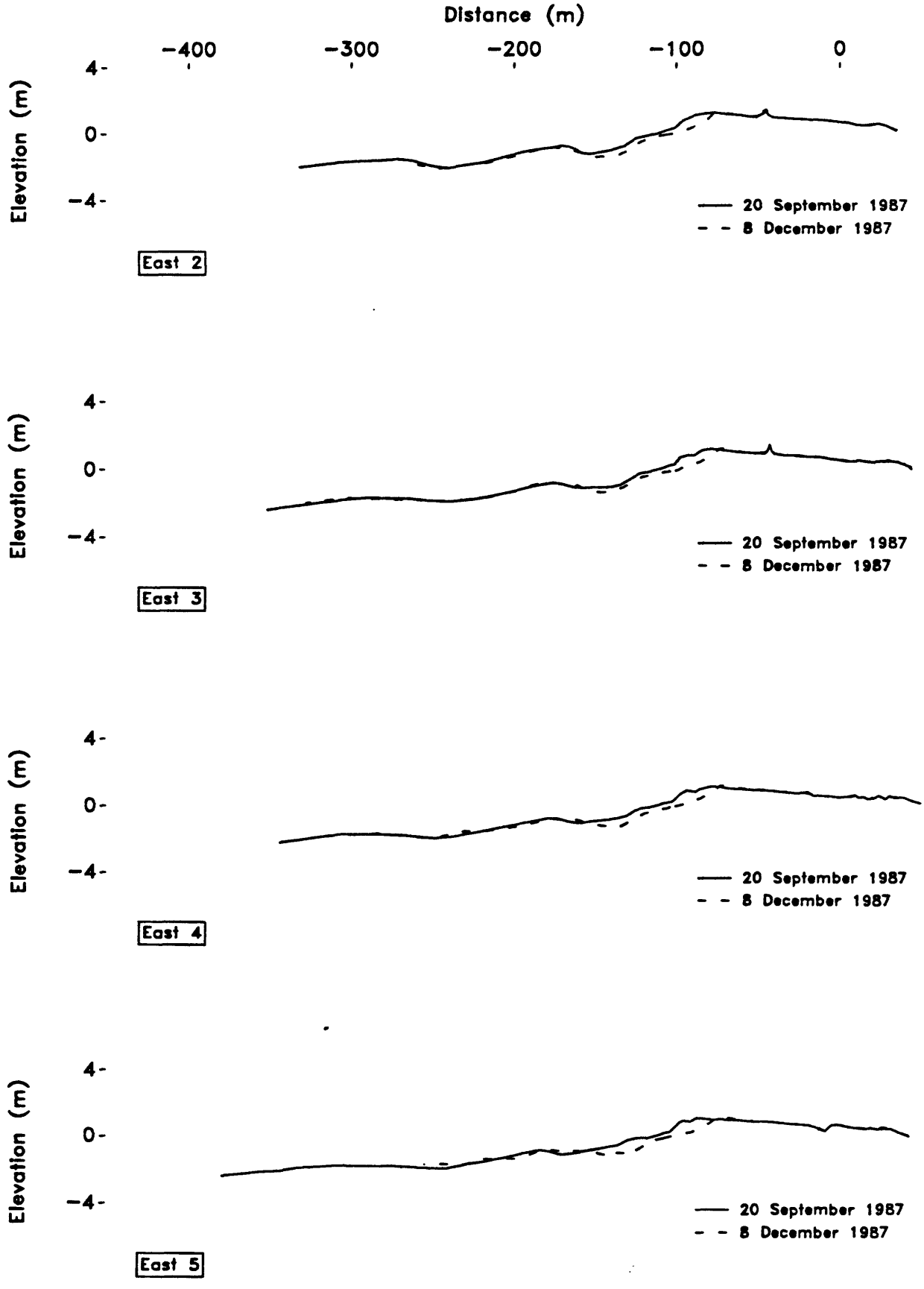

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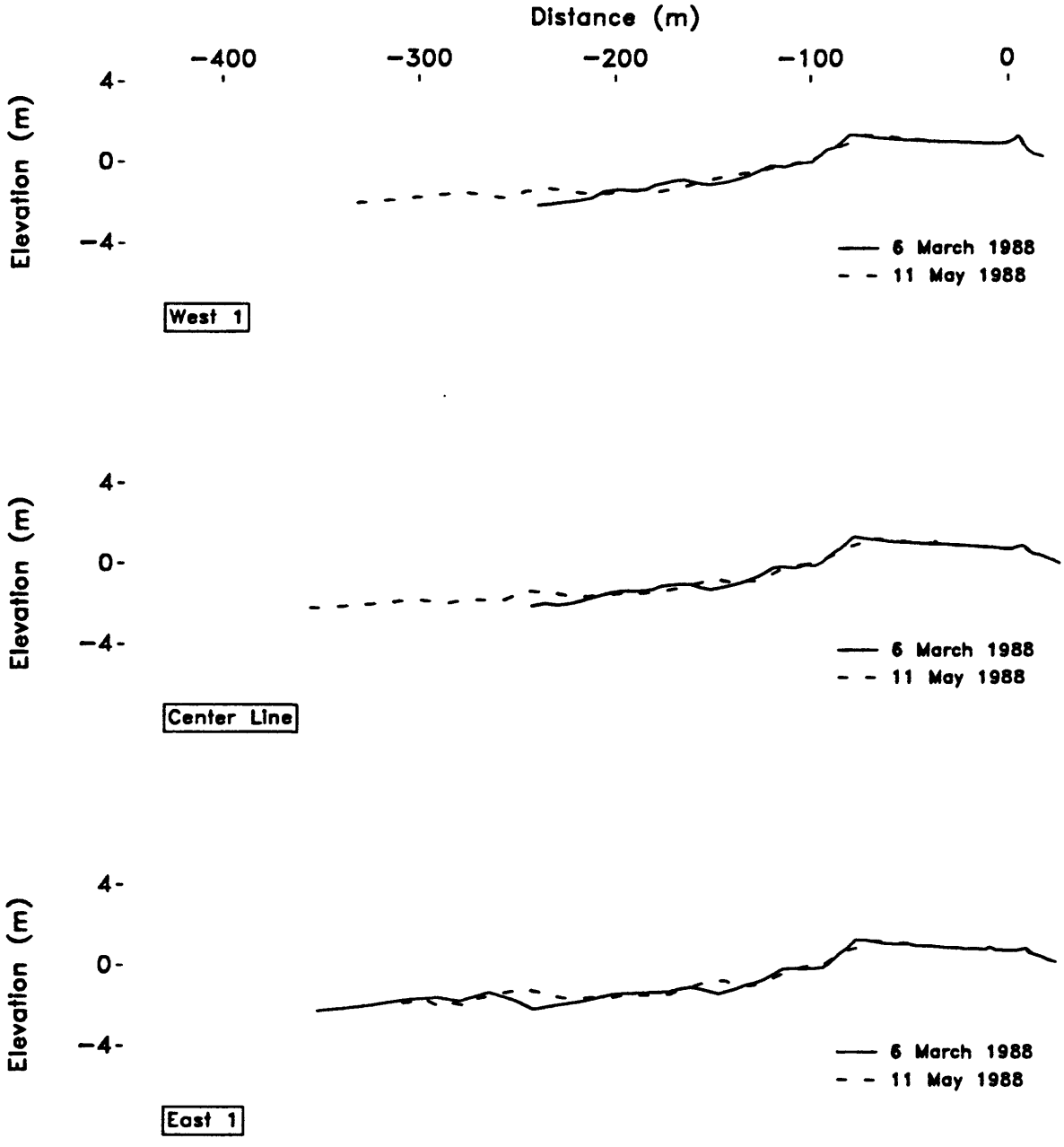
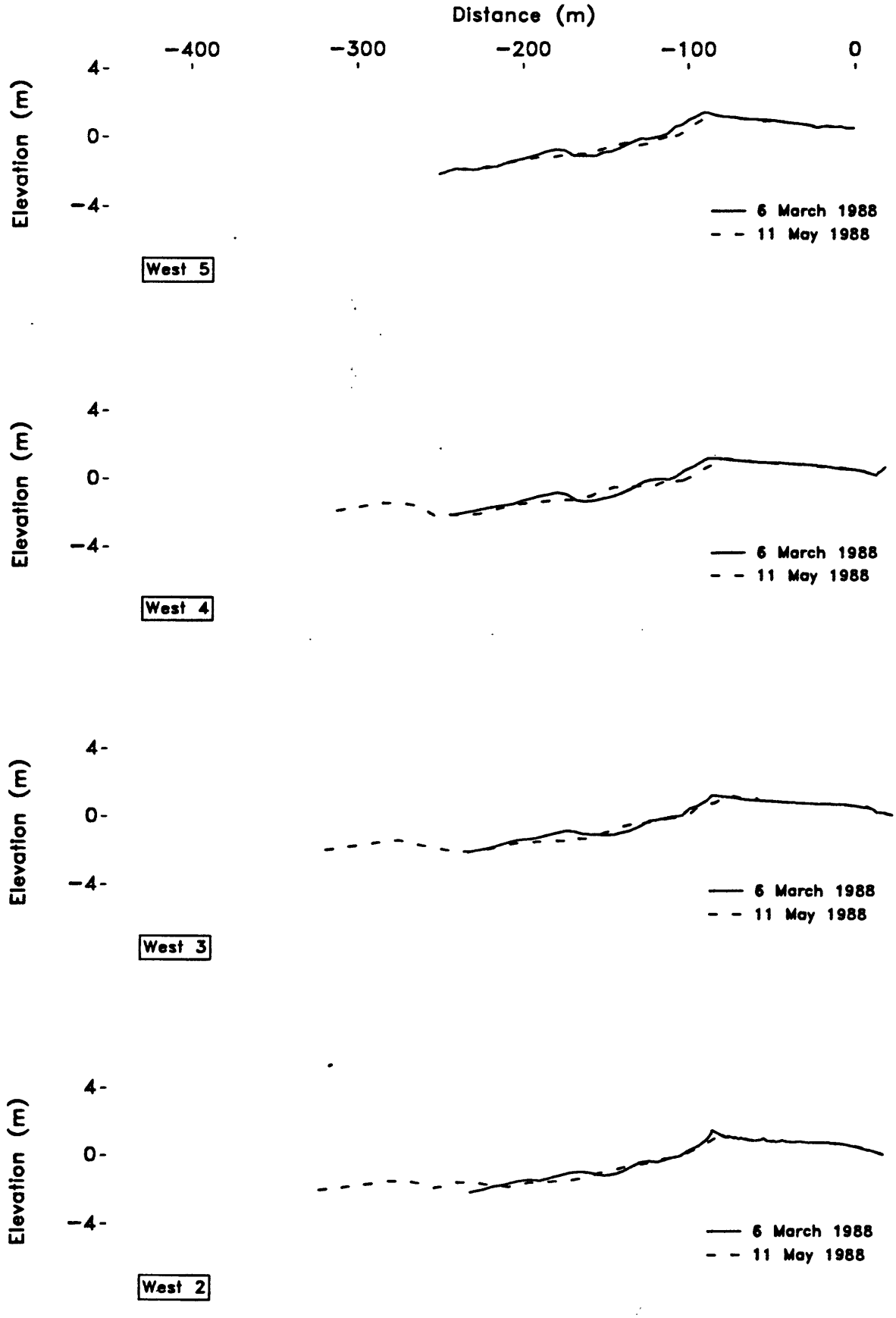


Figure 4. (Page 1 of 3) Eleven profiles from the March and May 1988 surveys. The profiles appear on three pages. Vertical exaggeration is 10 times.



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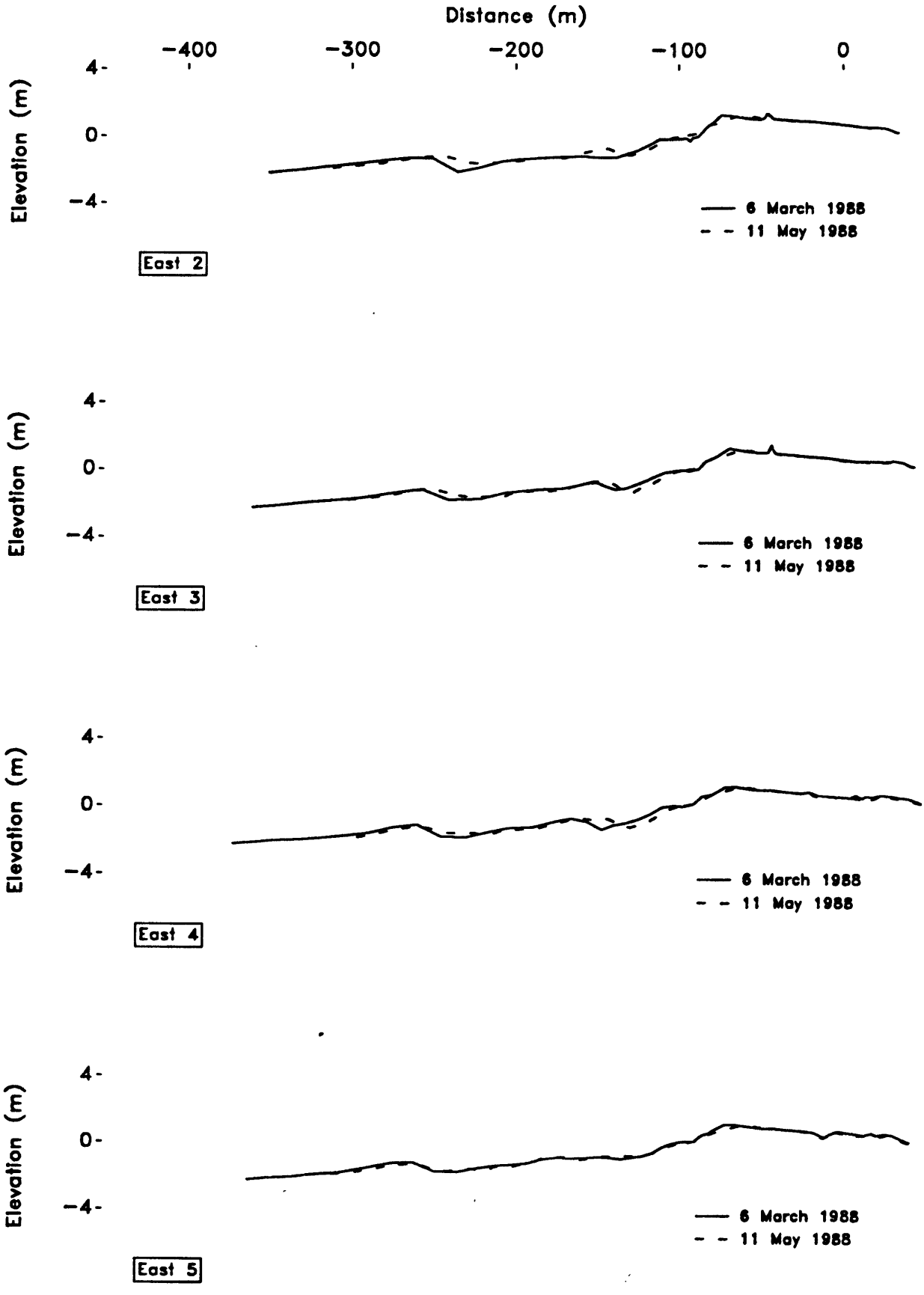

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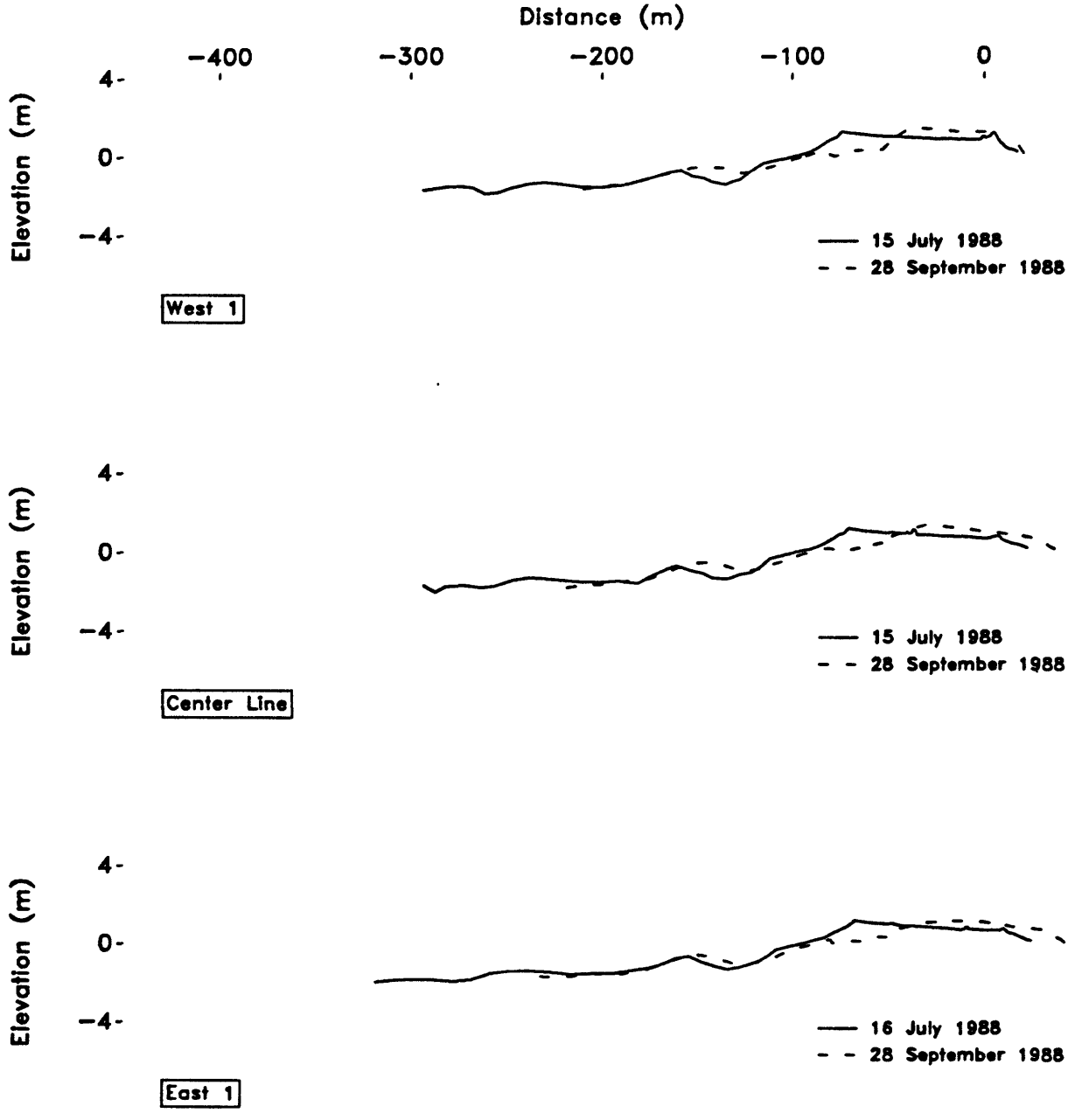
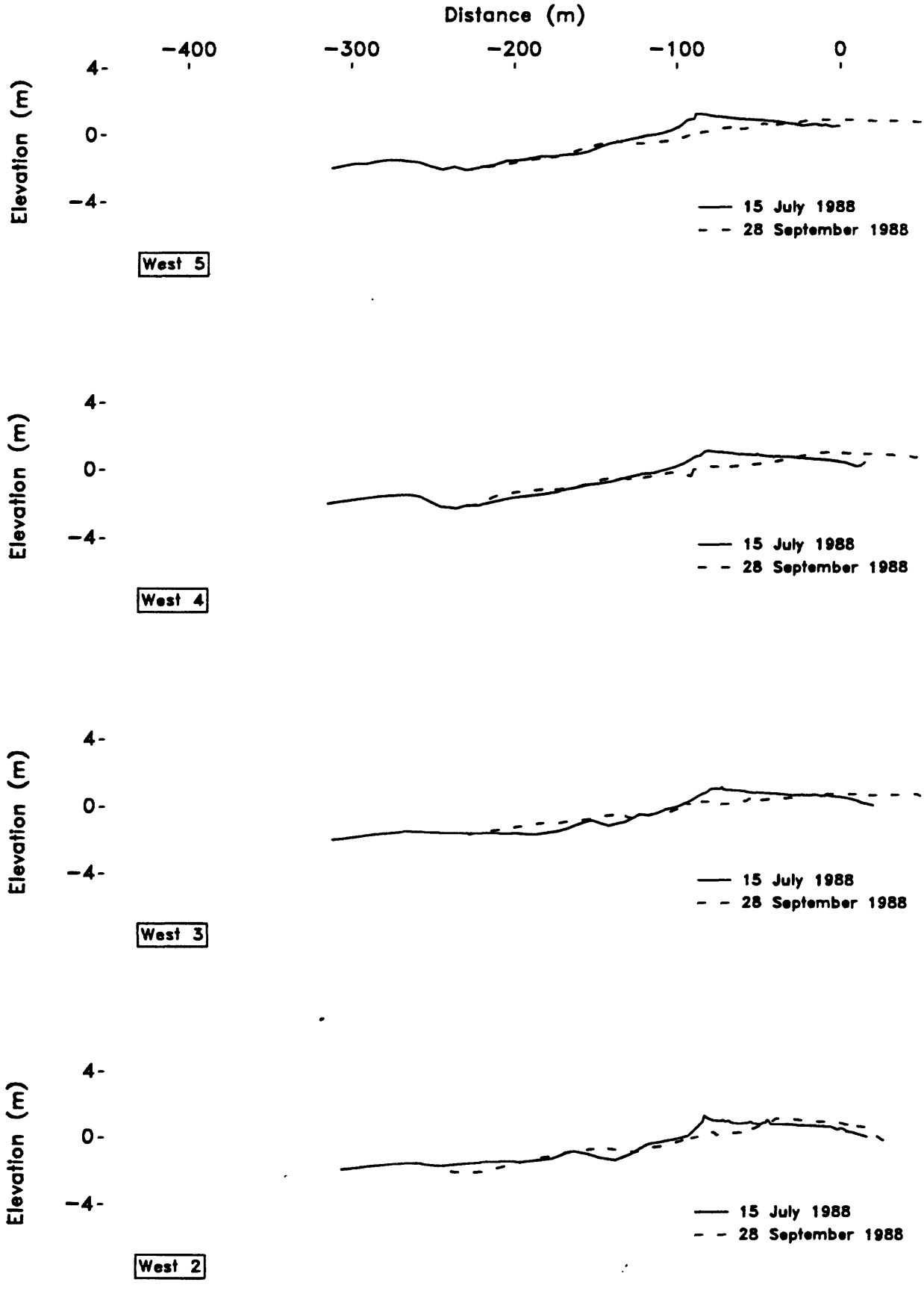


Figure 5. (Page 1 of 3) Eleven profiles from the July and September 1988 surveys. The profiles appear on three pages. Vertical exaggeration is 10 times.



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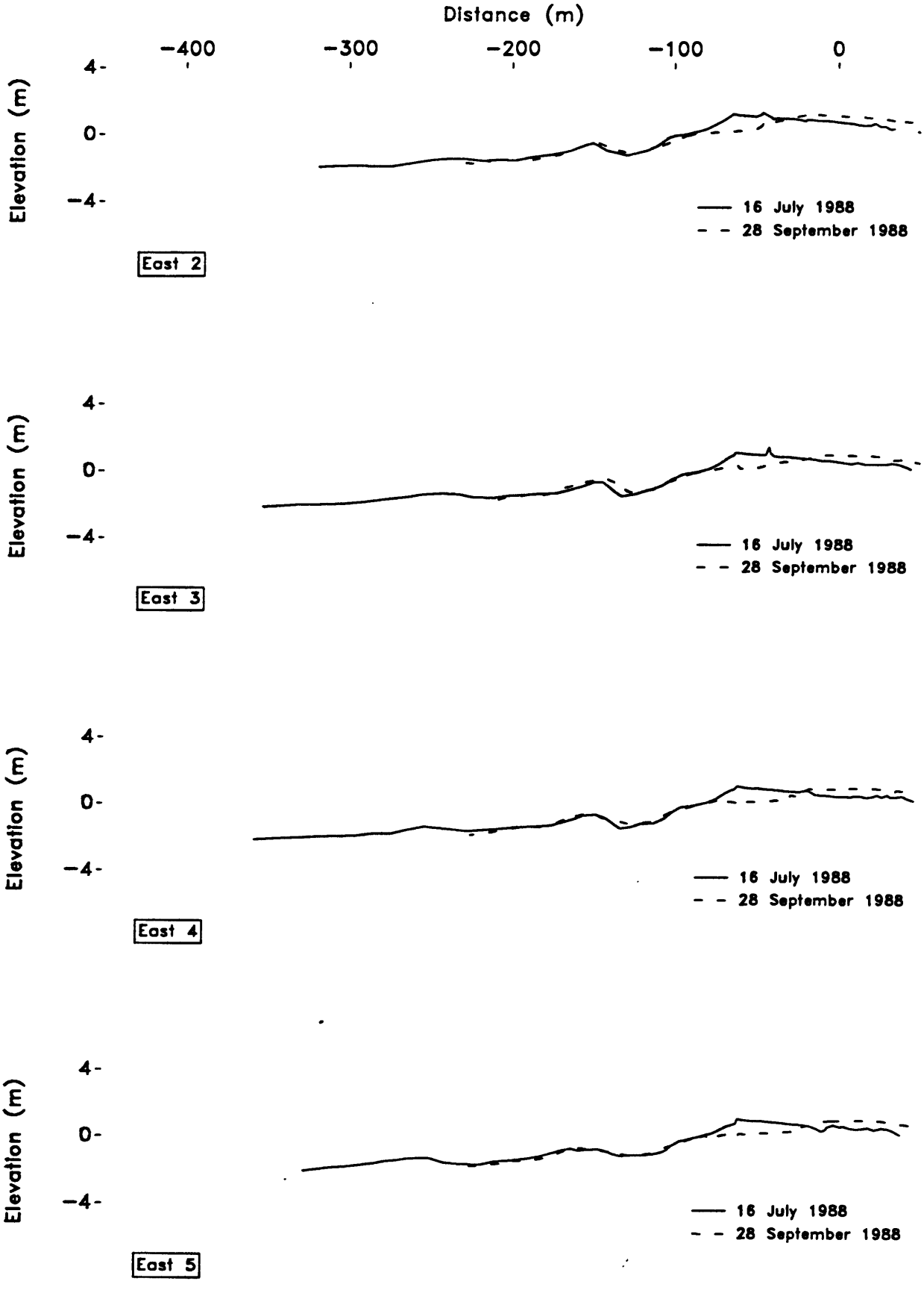

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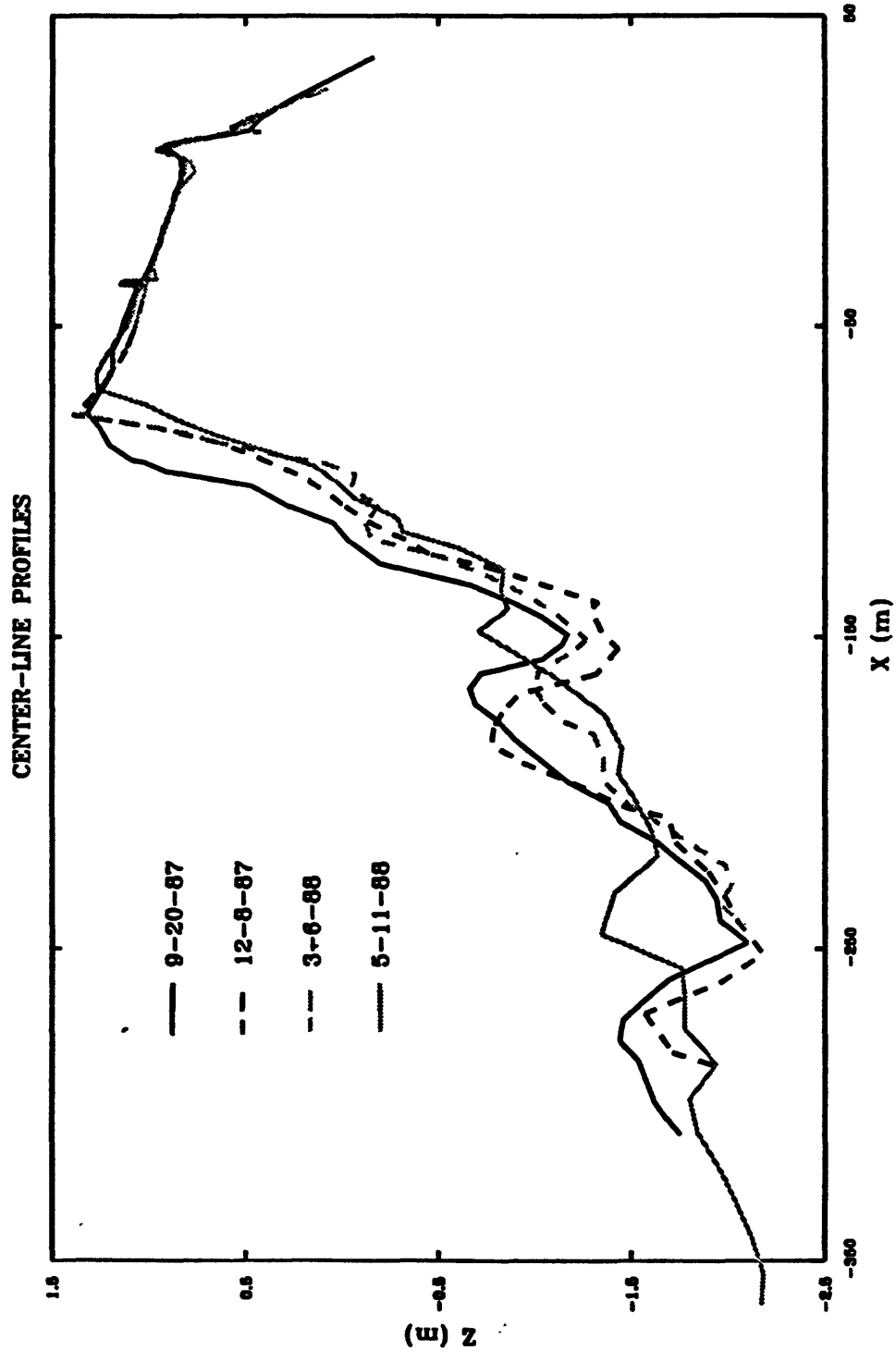


Figure 6. Centerline profiles from the September 1987, December 1987, March 1988, and May 1988 surveys.

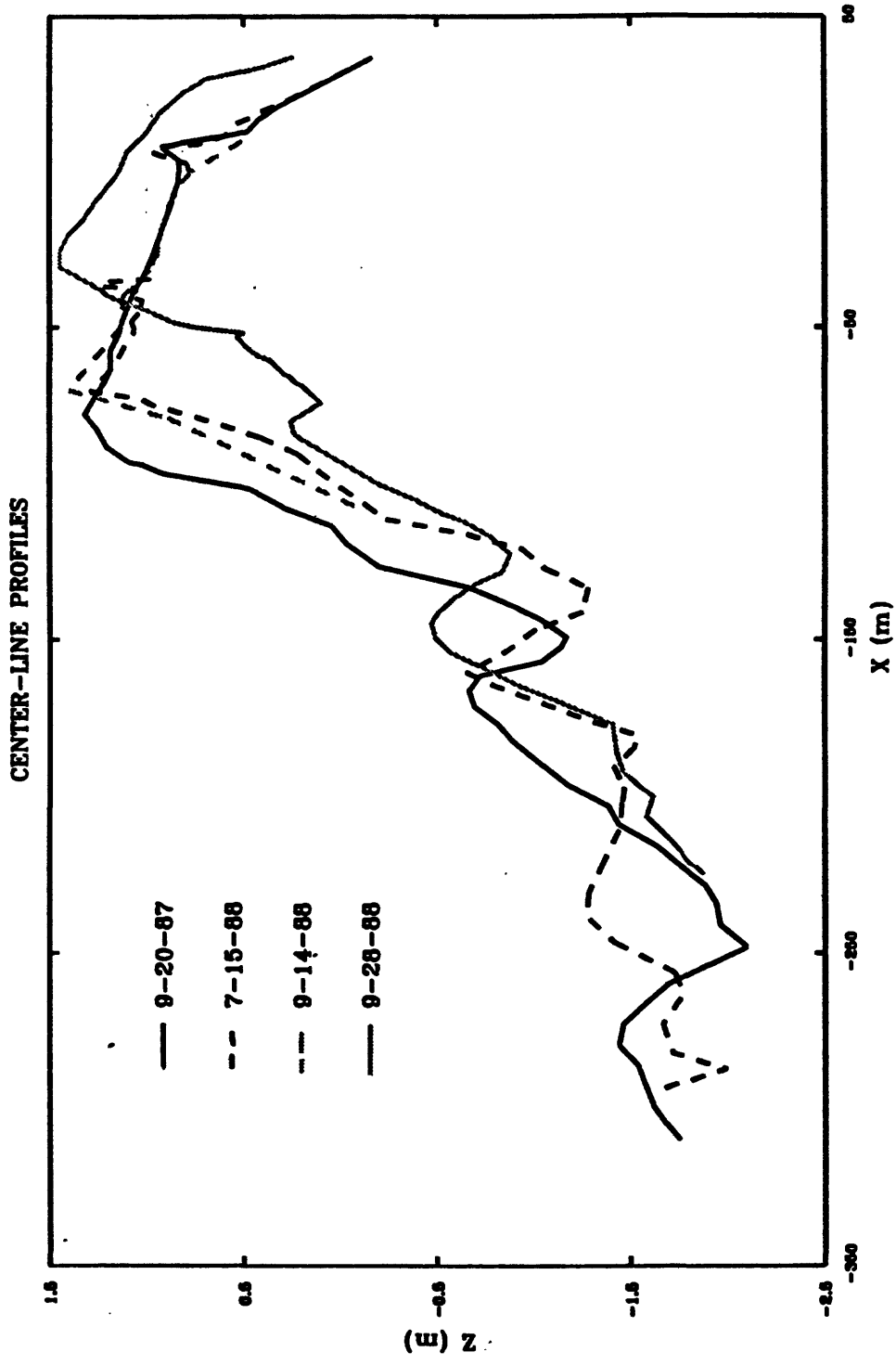


Figure 7. Centerline profiles from the September 1987, July 1988, 14 September 1988, and 28 September 1988 surveys.

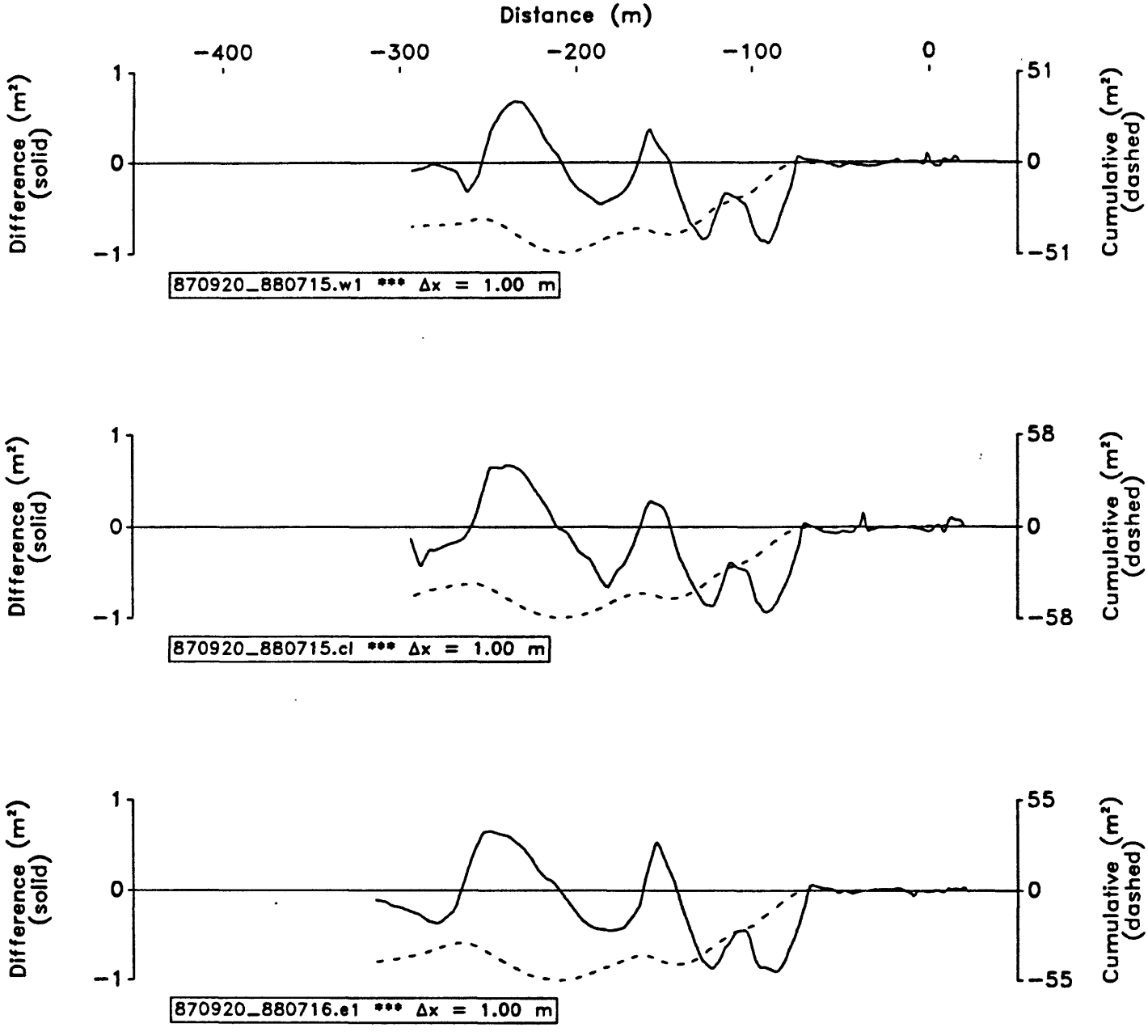
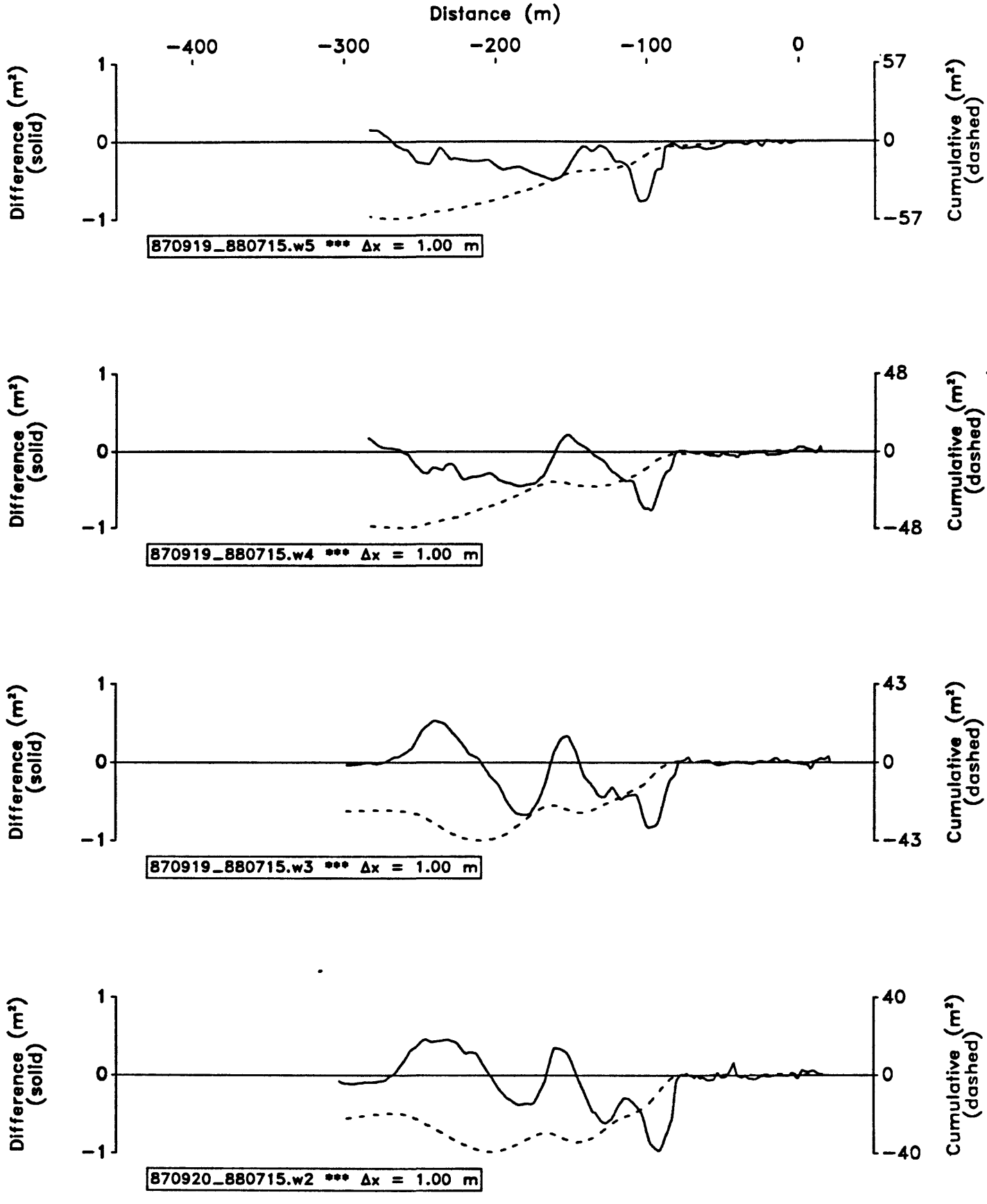


Figure 8. (Page 1 of 3) Profile changes between September 1987 and July 1988. The solid line is the difference in elevation between the two surveys (positive is accretion) and the dashed line is the cumulative change starting at the northernmost common point of the surveys. Note that the Cumulative Axis has a different scale than the Difference Axis. The label on the lower left side of each graph gives the dates of the first and second surveys and the line number (for example, w5 stands for line West 5).



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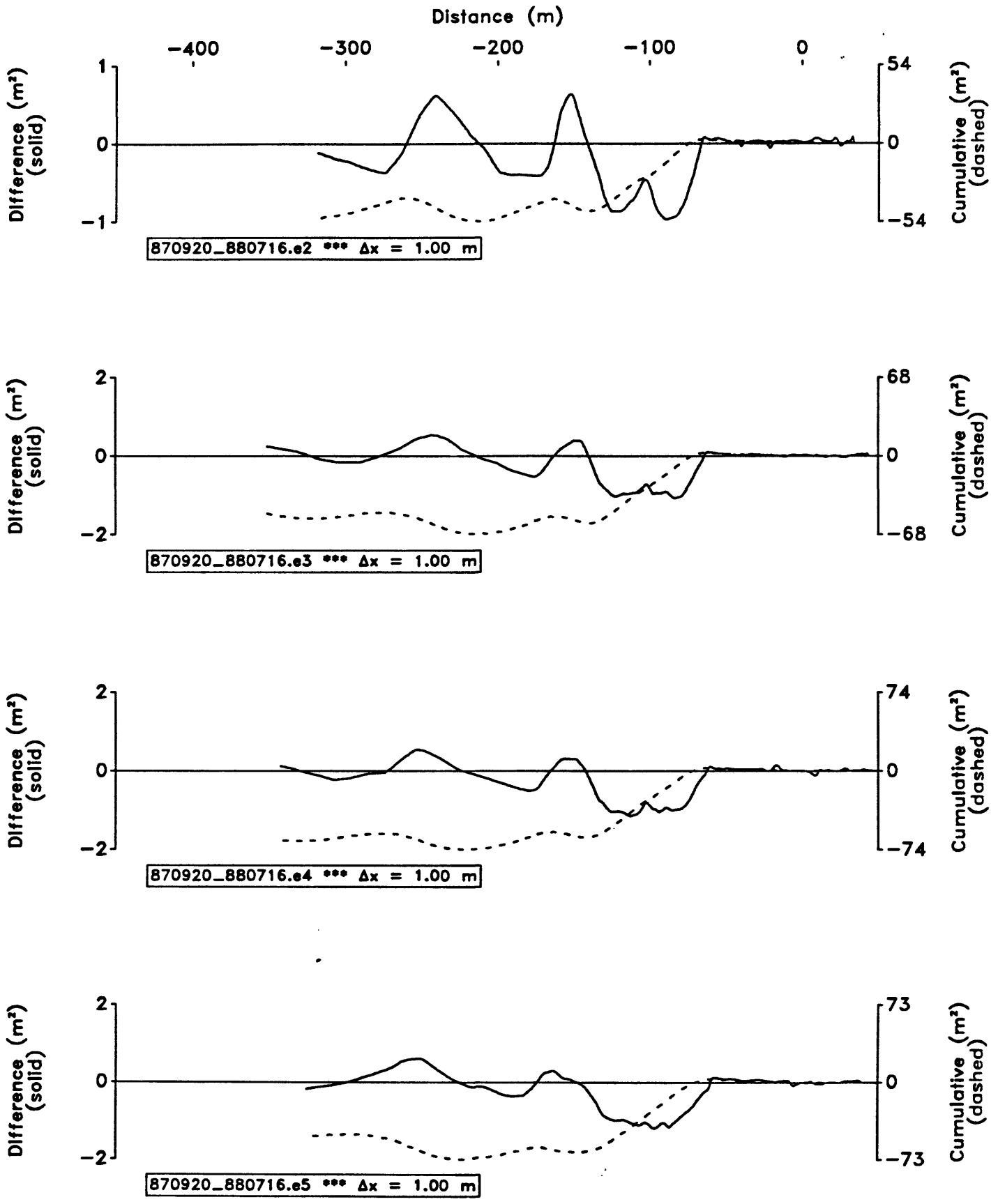

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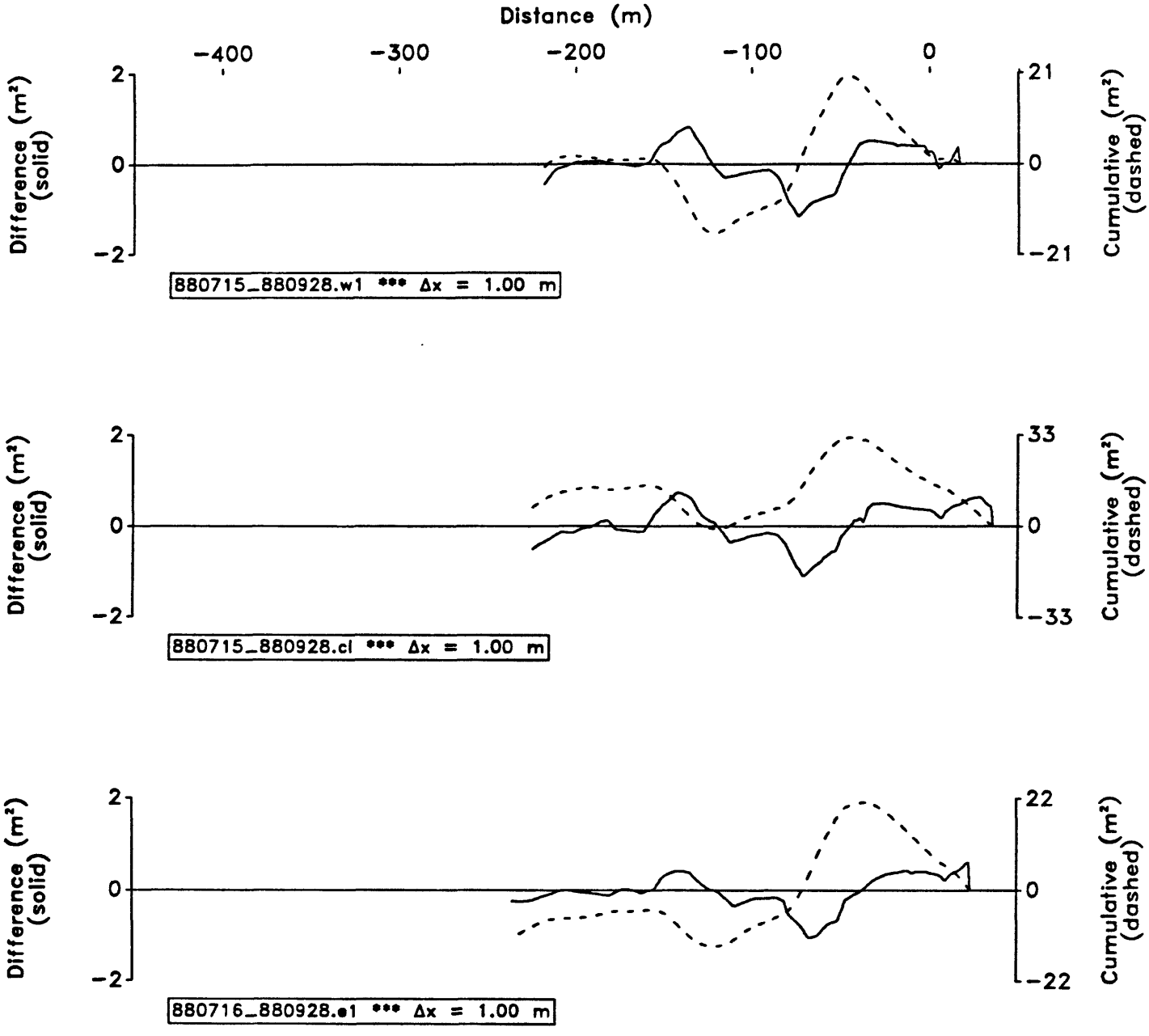
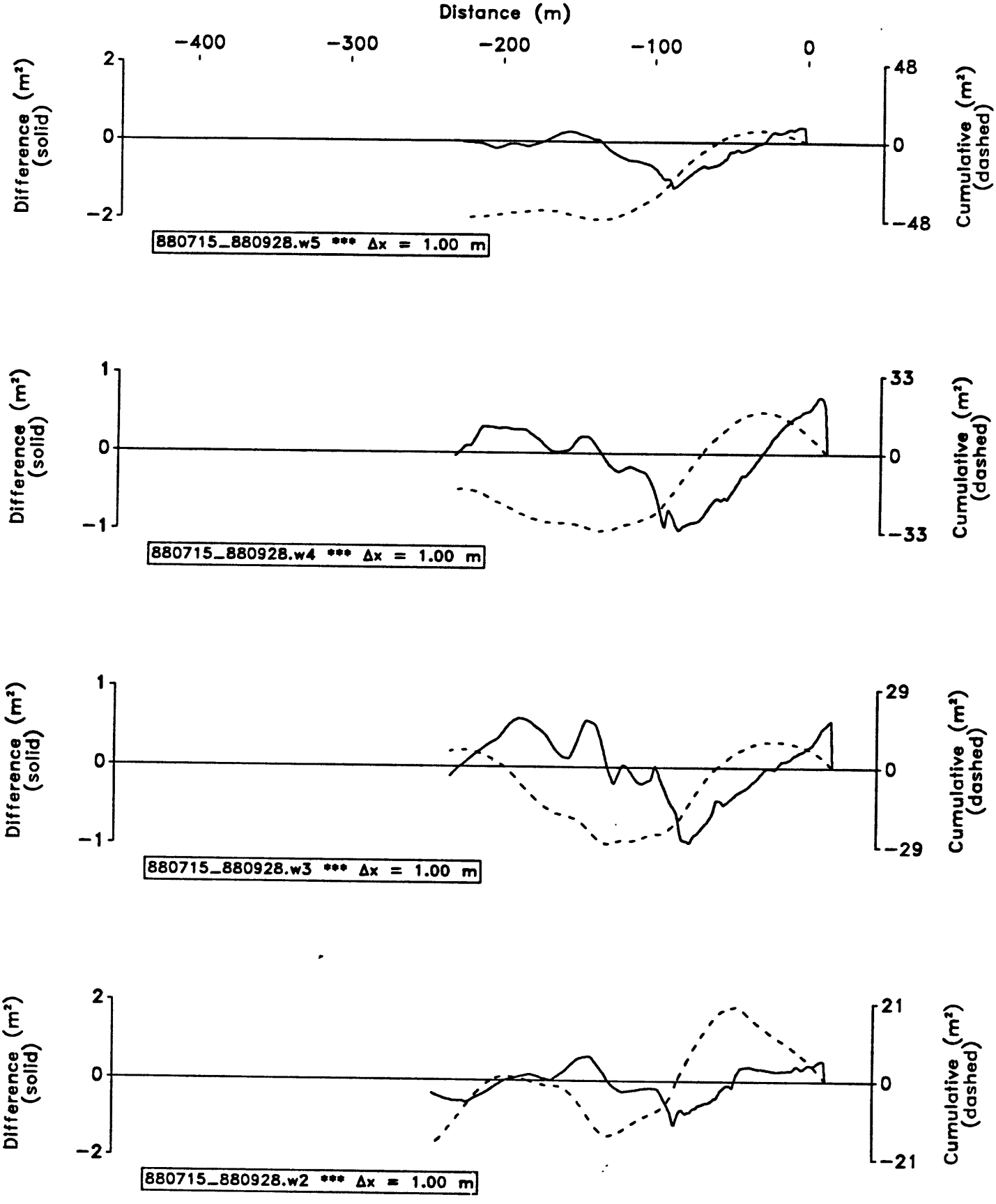


Figure 9. (Page 1 of 3) Profile changes between July 1988 and 28 September 1988. The solid line is the difference in elevation between the two surveys (positive is accretion) and the dashed line is the cumulative change starting at the northernmost common point of the surveys. Note that the Cumulative Axis has a different scale than the Difference Axis. The label on the lower left side of each graph gives the dates of the first and second surveys and the line number (for example, w5 stands for line West 5).



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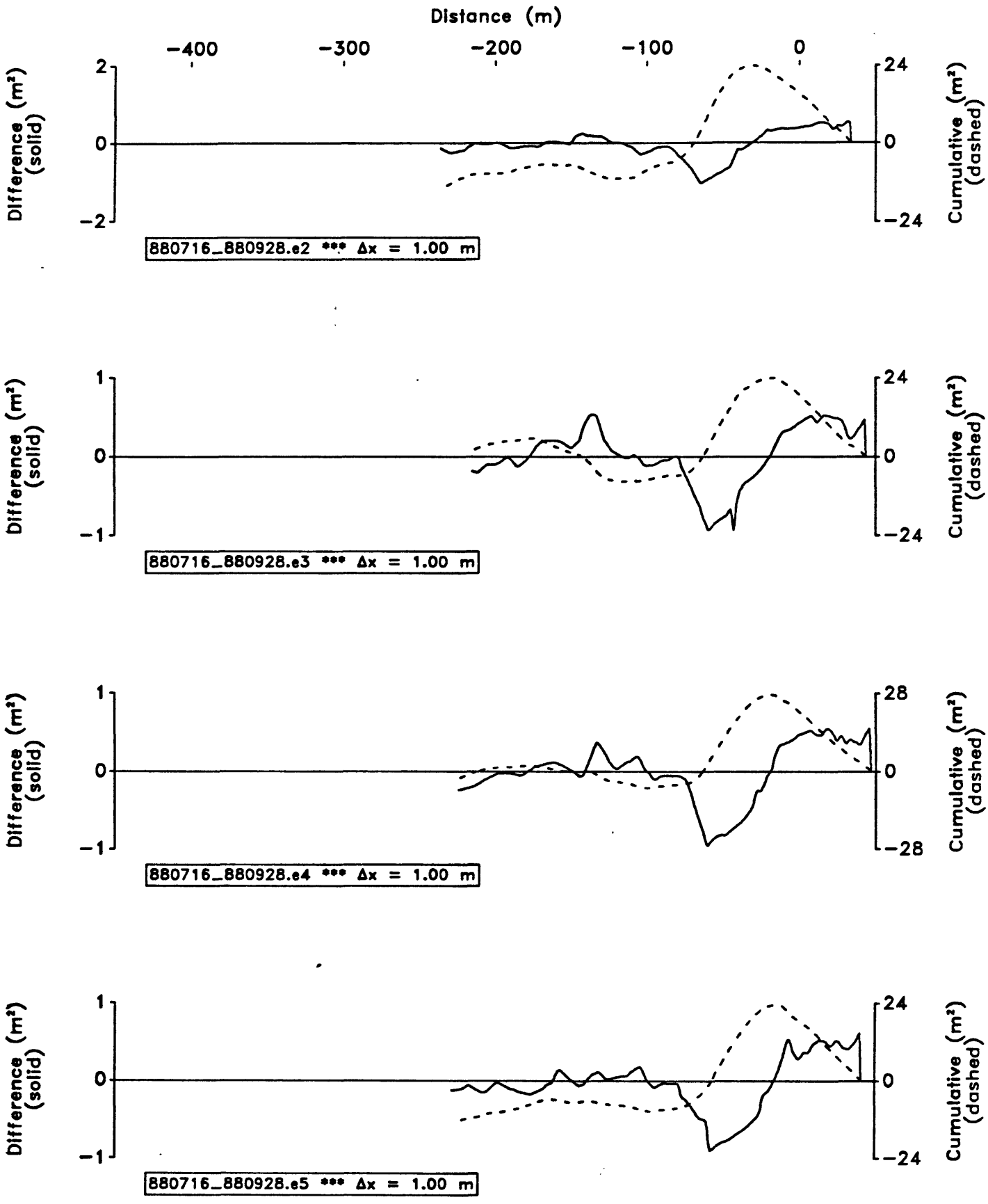

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