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ROOF CONTROL STUDIES AT

OLGA NO. 1 COAL MINE, COALWOOD, WV

by

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INTRODUCTION

The low coal section of Olga No. 1 Mine, Coalwood, WV is located in the northwest corner of the property, about 3 miles (underground track distance) from the main man/supplies shaft. It was developed by driven main haulage-ways (West Main A) along the northern boundary and mined by longwall method. Longwall panels were developed by four-entry system at approximately 360 ft. center-to-center from the main haulageway to the southern boundary. The length of longwall panels ranged from 1200 ft. to 4100 ft. Entries are 18 ft. wide and chain pillars are at 60 ft. center between entries and 100 ft. center between crosscuts except the tail entry pillars were 125 ft. center between entries.

The layout of haulage ways and panels were guided by an early geological study in which surface and underground reconnaissance found that there were three prominent joint sets in Olga No. 1 Mine. One striked at N 40^{o}-65^{o} W, and the other two at N 05^{o}-20^{o} E and N 35^{o}-45^{o} E. A joint set intersecting an entry at larger than 20 degrees was reported to have no effect on the stability of the entry (1). It was under this guideline, W.M.A was oriented at E-W direction. Furthermore, the orientation of longwall face was parallel to major joint sets and would facillitate roof caving in the gob area. (Fig. 1)

Face supports were the 560 tons, 4-legs self-advancing frame supports made by Westfalia and spaced at approximately 4 1/2 ft. center. During development, resin bolts with rebar 3/4-in. diameter by 48-in. long spaced at 48" center were used. During retreat mining, 7" x 9" wooden posts set at 5 ft. center were placed for a distance of 400 ft. ahead of the longwall face in both head- and tail-entries. The T-junction area of both entries were further reenforced by setting rows of 25-tons hydraulic jacks for a distance of 80 ft. outby the face and thus providing a support density of approximately 2 tsf.

In the headentry, however, vertical shear failures along the intersection of chain pillar rib line and roof occurred at irregular intervals and kept approximately 25-30 ft. ahead outby the face after the initial 3 crosscuts had passed. Consequently, the wooden posts set along and/or close to pillar rib line were frequently either crushed and failed or pushed into the floor sometimes as deep as 8 inch. In spite of this, mining of coal was seldom interrupted due to roof control problems.

There are other roof falls that occurred during the entry development and that obviously were not related to mining of coal itself. The most significant ones are those which occurred in (1) 3rd entry of 10 Left near West Main-A, (2) Washout area and nearby marginal zone in West Main-A, and (3) 5-, 6-, and 7-Left. (Fig. 1)

Therefore, it appeared that two factors that control the fall of roof in Low Coal Area of Olga No. 1 Mine. One is related to coal extraction while the other is independent of coal extraction and has to do with local geological features. Accordingly, roof control study in this area is divided into two parts: One is the magnitude of pressure buildup at various locations around longwall panel from which optimum support density at the head-and-tail entry and pillar size can be estimated. The other one is the identification of any geological anomalies and correlation of roof fall with these anomalies. This will provide information as to the locality and extent of bad roof where additional supports are required. However the 2nd portion concerning the geological effects will not be reported here due to space restriction. (see Ref. 1)

UNDERGROUND LONGWALL INSTRUMENTATION

The effects of retreat mining on the behavior of the 8th panel were investigated by monitoring entry convergence, and pressure changes in the panel, chain pillars and the immediate roof of the entries. Fig. 2 shows the detailed layout of the instrumentation station which is located between 660 and 800 ft. from the starting point of the longwall retreat mining. The number and location of various gages were arranged so that a complete pressure profile could be obtained.

Vibrating wire stressmeters were used to measure the stress changes in the panel and chain pillars. They were installed by drilling boreholes to various points of interest. Two stressmeters, one in vertical and the other in horizontal directions, were installed in each borehole. The principles and techniques of installing vibrating wire stressmeters have been described elsewhere (2). The pressure changes in the immediate roof of the head-and tail-entries were monitored by inserting 4"x 4" pressure cells between the ends of the posts and roof line while the entry convergences were determined by regular rod extensometers. Readings were taken regularly as the face moved in. But when the moving working face was near the instrumentation station, more frequent readings were taken.

1. Stress Changes in the Panel and Chain Pillars

The vertical stress increase or abutment pressure induced by the moving face was first felt with very mild but continuous rise approximately 500-600 ft. ahead of the longwall face. It increased very rapidly when the face moved to within approximately 60-100 ft.

Specifically, the front abutment (Fig. 3) as measured by Gage #2 which was 5 ft. deep reached a maximum of 1500 psi when it was 33 ft. outbye the face whereas a maximum of 3120 psi was registered by Gage #4 which was 30 ft. deep when the face was 17 ft. away.

Some typical abutment pressures in chain pillars are shown in Figs. 4 and 5 for 8 Left and Figs. 6, 7 & 8 for 9 Left. The side abutment pressure was highest in the first chain pillar near the panel and decreased as it moved away from the panel in each chain pillar. The abutment pressure on the side near the panel was higher than that of the far side and its increase in the center of each pillar was insignificant.

The same figures also show that the horizontal pressures increased with the vertical one although the magnitudes of increases were relatively small.

. Stress Changes in Head- and Tail- Entries

The pressure changes induced by moving longwall face at head- and tail-entry were measured by hydraulic pressure cells. Six hydraulic cells were installed in headentry (3 in a set for one location), one set was installed between pillar and longwall panel while the other at the intersection of crosscut and headentry/or tailentry for evaluating the effect of intersection. The hydraulic cells were inserted between the 7" x 9" wooden post and roof line with the help of wooden wedges for complete tight fit (Fig. 8).

In headentry however, the advance equipment such as motherline conveyor and mule trains extended approximately 160 ft. outby the face. Most of the cells (No. 7, 8, 8, 10, 12 and 47) were destroyed by this advance equipment. Several cells (Nos. 1 to 6) were installed in the vicinity of intersection one pillar block outby the old station.

Figs. 9 and 10 showed stress change as monitored by pressure cells at head- and tail-entry. Several phenomena found in stressmeter readings were also seen in pressure cell readings. For example, pressure increase in head- and tail-entry roofline was first experienced when the face was approximately [illegible] ft. inby and started to buildup rapidly as it moved to within 70-50 ft. of cell locations. Pressure kept increasing (cell No. 19) or dropping rapidly (cell Nos. 2-4) depending on whether the roof in the vicinity collapsed or not when the face passed the cell locations. It should be noted that cell Nos. 1 to 6 were installed when the face was only 60-90 ft. inby and might not pick up the maximum possible pressures there. However, the maximum pressure registered by each cell was quite high as compared with those measured in the corresponding positions in tailentry. One of them (cell No. 4) even exceeded the maximum pressure range (3000 psi) of the pressure gage.

The magnitude of pressure increase differed from each other mainly depending **on where** the pressure cells were located. In tail-entry, for example, cell No. 11 which was placed closest to the 1st chain pillar ribline experienced least pressure increase (300 psi) among the 3 cells installed between panel and chain pillar. Pressure change appeared to increase slightly as it moved from pillar ribline to panel ribline (i.e. pressure for cell No. 11 < 21 (630 psi) < 13 (740 psi)). The pressure increases for cells installed at intersection in tailentry were somewhat different but the maximum of the 3 cells was cell No. 18 located near panel ribline and the minimum at the center of the entry. The last readings when the face was about 10 ft. inby for these 3 cells were 1450, 1100, and 850 psi for cell Nos. 18, 19, and 20, respectively. However, the pressure exceeded the maximum capacity (3000 psi) of the pressure gage for cell No. 19 when the face was about 10 ft. pass the cell.

In headentry of 9 Left, not enough data was obtained for the area between pillar and panel. But the pressures recorded at intersection of crosscut and headentry were much higher than the corresponding positions in tailentry.

3. Entry Convergences

Convergence stations were installed at belt-, track- and 3rd-entry of 9 Left. Unfortunately, the convergence station in head (belt) entry was destroyed by the hydraulic jacks of mule train before any significant convergence was observed.

Figure 11 showed the convergence as monitor for track- and 3rd- entry of 9 Left. A total of 1 1/2 inch convergence was seen in track-entry while a fluctuation reading for 3rd entry resulted in more than 1/8 inch of extension in entry height.

DISCUSSIONS AND CONCLUSIONS

The maximum abutment pressures measured in 9C pillar and headentry were larger than those in 8A pillar and tailentry. This might attribute to either the entries were too wide or the 1st chain pillar in the headentry was too small. Both of which could cause the ever-present shear failure in the roof of the head-entry. But an entry width of 18 ft. was absolutely necessary in order to deliver the minimum air quantity at the face set by the law. Therefore, the problem reduced to the determination of the optimum-sized chain pillars.

The design of chain pillar requires the following three items of information: applied load, stress distribution and strength of the pillar. Applied load includes stress concentration induced after entry development and abutment pressure due to retreat mining. Stress concentration in the pillar immediately after entry development was obtained by finite element method because in-situ overcoring technique failed to obtain any meaningful result. The abutment pressure used for pillar loading calculation should be the maximum in the abutment pressure history. The maximum abutment pressure obtained by the vibrating wire stressmeters was that when the face was approximately 300 ft. behind the gages. Every chain pillar experiences two separate abutment

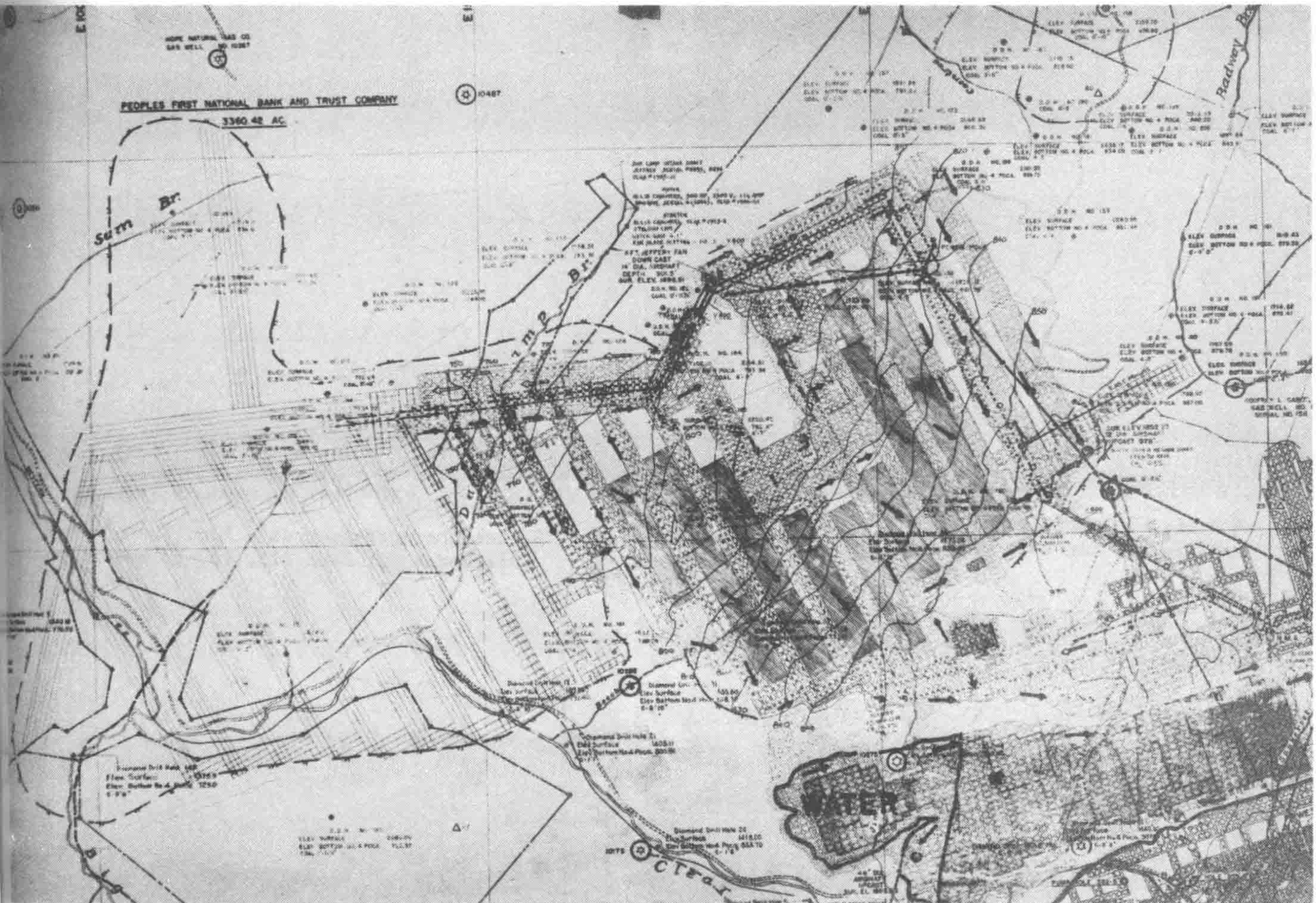


Fig. 1 The Low Coal Area of Olga No. 1 Mine, Coalwood, WV

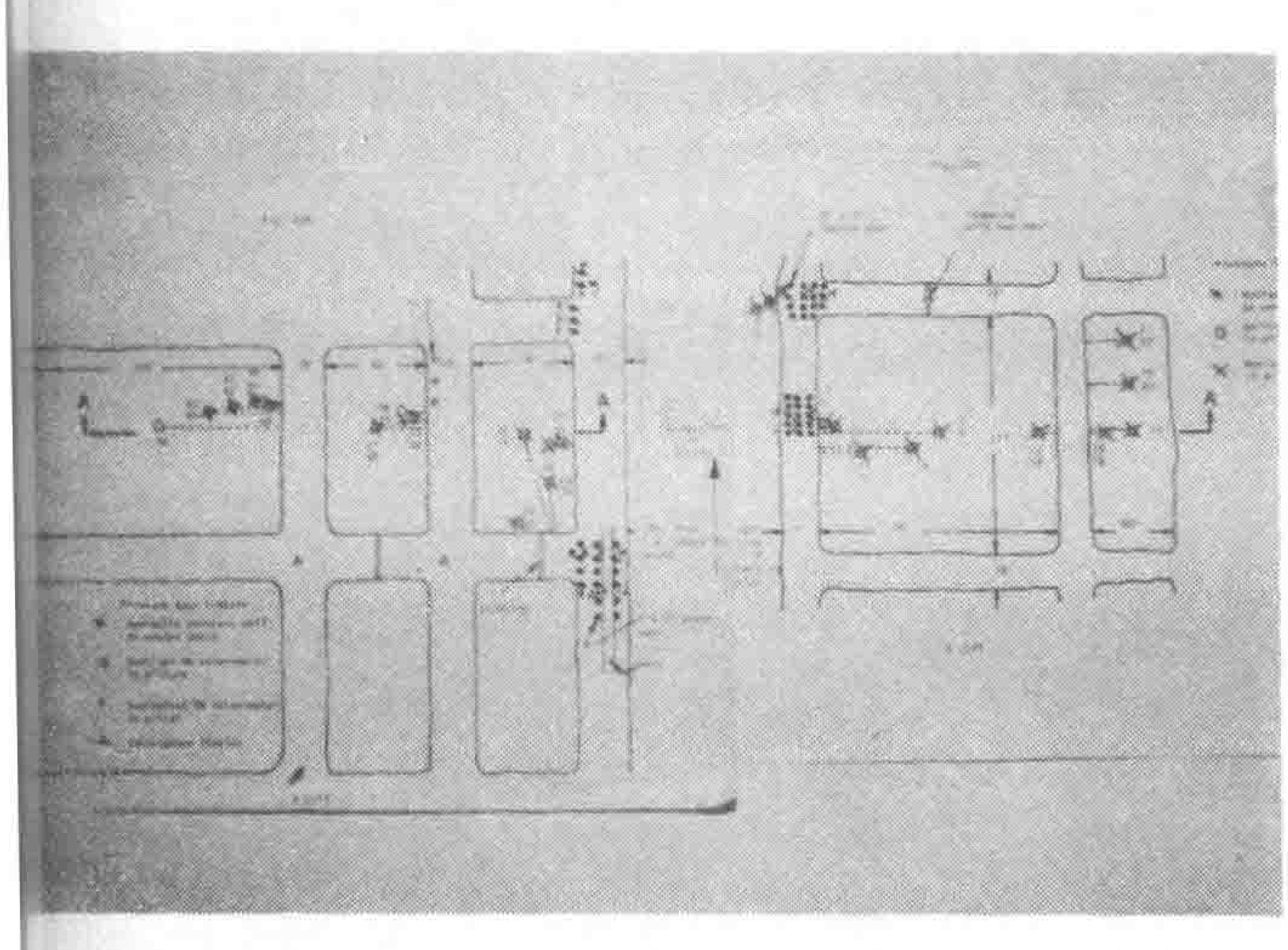


Fig. 2 Underground Instrumentation Layout at 9th Panel

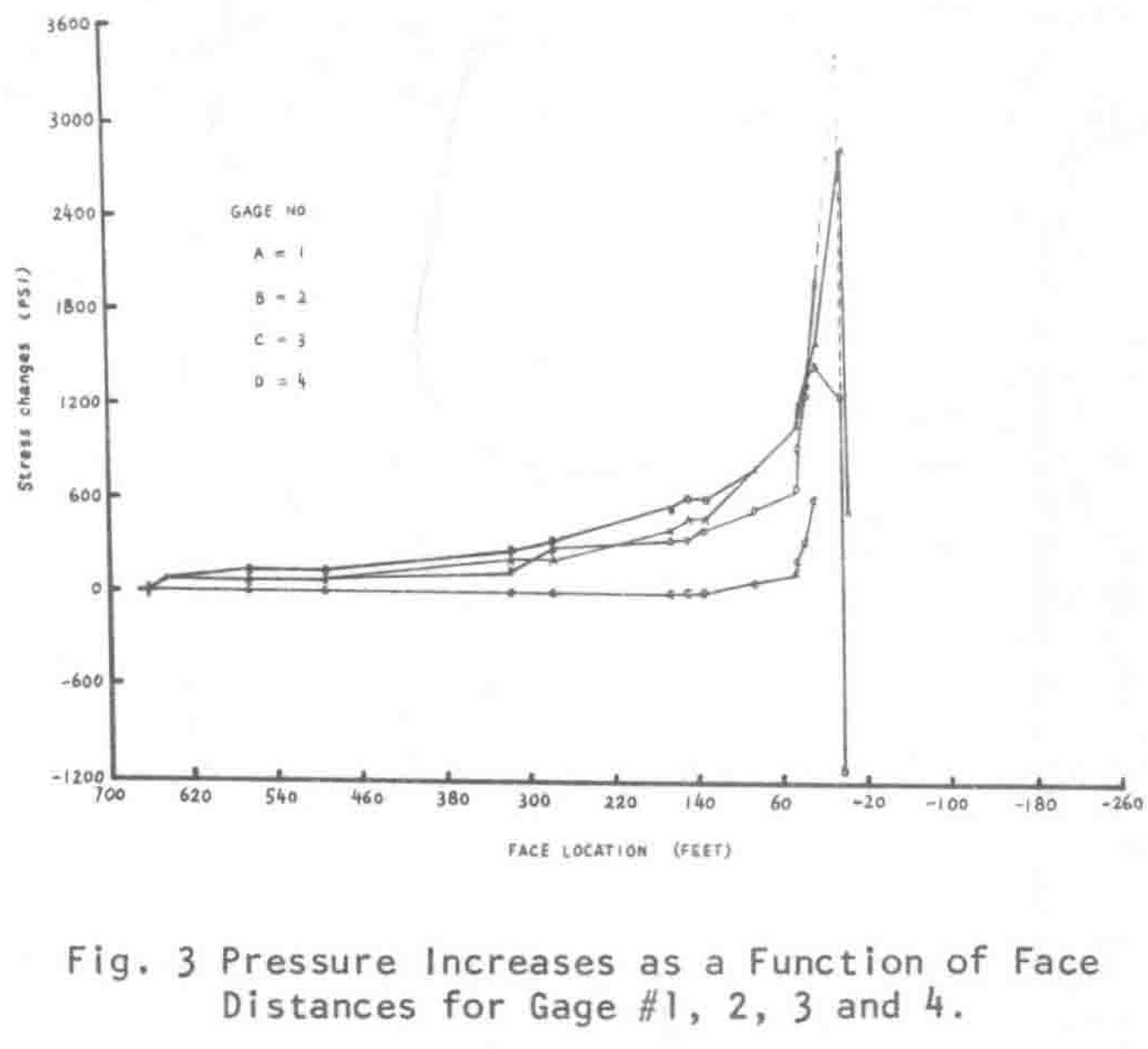
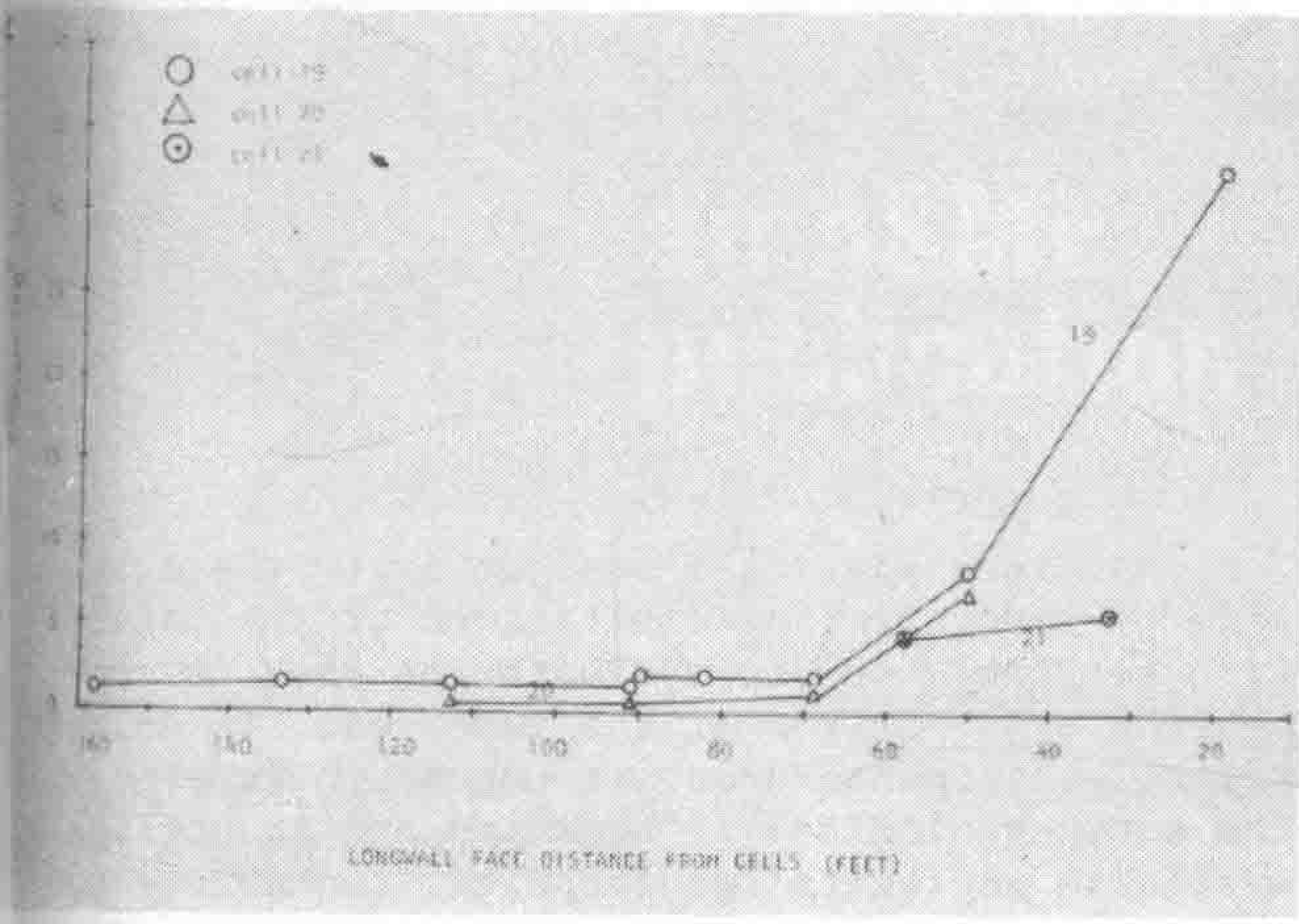


Fig. 3 Pressure Increases as a Function of Face Distances for Gage #1, 2, 3 and 4.



g. 10 Pressure Changes at Tailentry

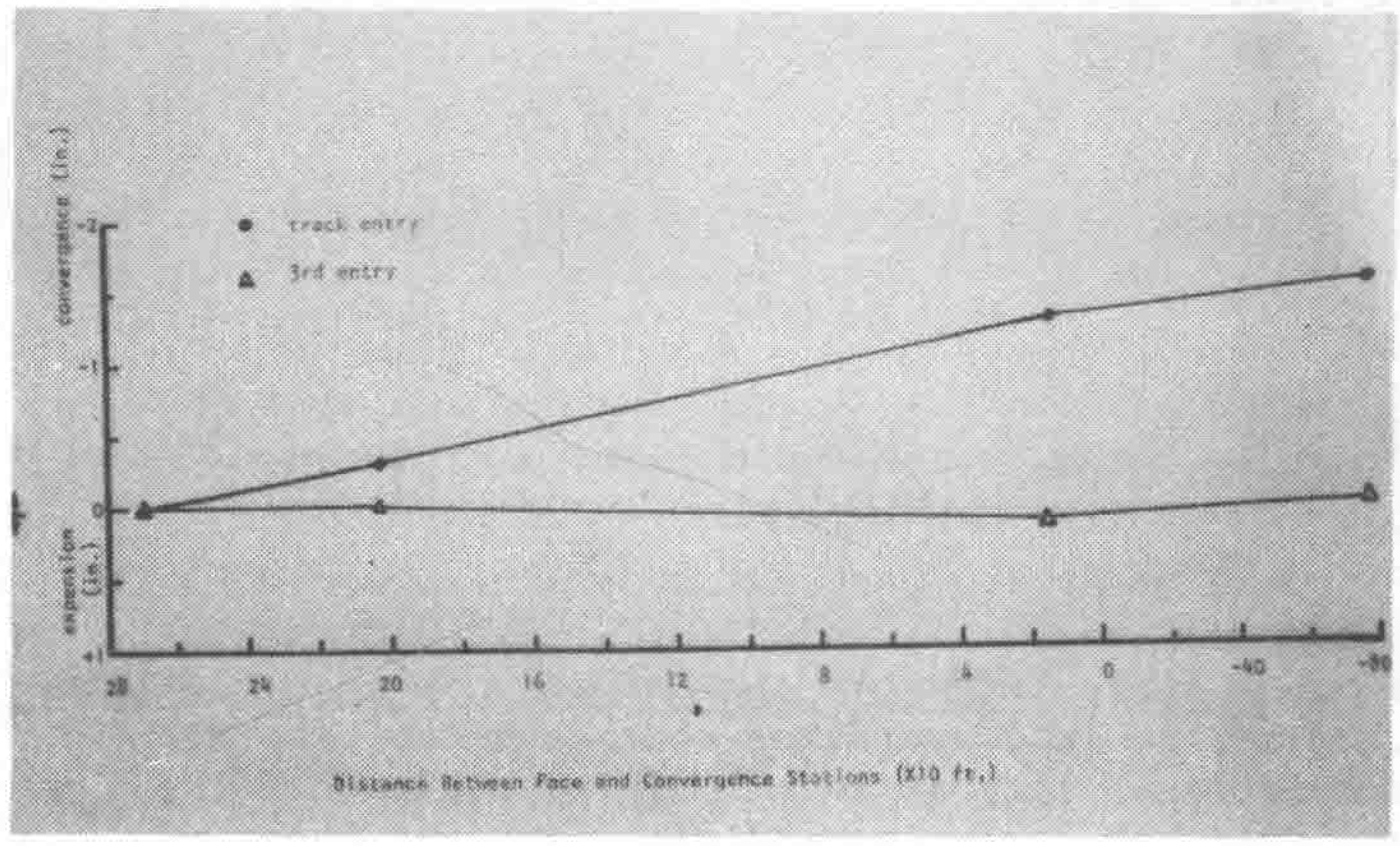
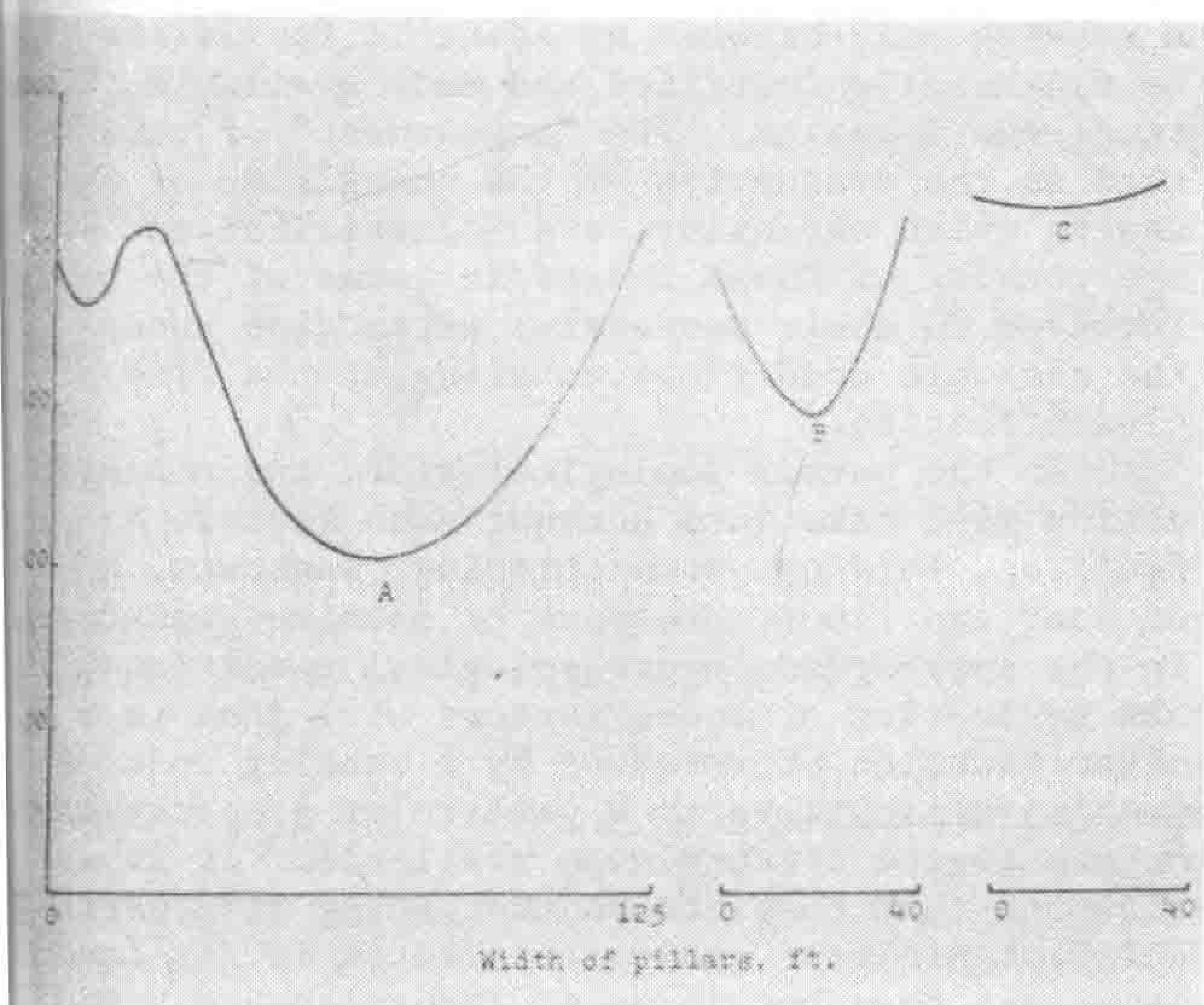


Fig. 11 Convergences at Track-and 3rd Entry etc
9 Left



. 12 Total Applied Stress Change Distribution In Chain Pillars

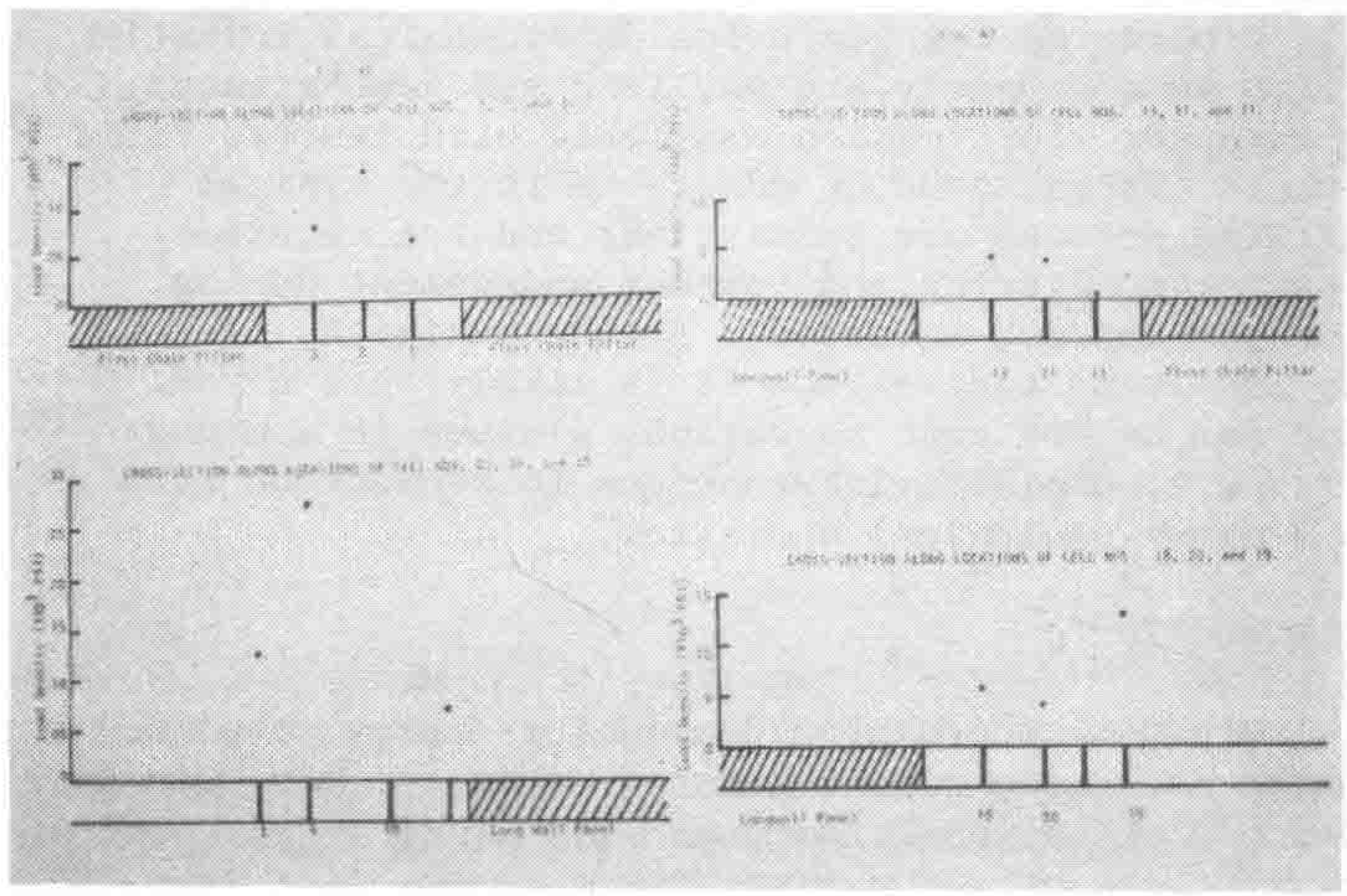


Fig. 13 Load Densities Measured at Head-and Tail-Entries