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18. FURTHER EXPLORATIONS AT FLAGSTAFF GULLY DAM

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During the current excavations designed to provide a cut-off trench along the axis of this dam a further leakage path has been encountered.

The new path occurs about 10 feet west of the original pipe and, unlike it, is irregular in plan. Where intersected, the path trends roughly at right angles to the axis of the dam but just north of the axis it turns abruptly and trends toward the intake area of the first leakage path. The downstream portion of the second leakage path has not yet been excavated.

This path, like the first one, is located along the interface of the clay core and the bedrock and extends upwards 2 to 3 feet into the core. This does not necessarily imply that the piping

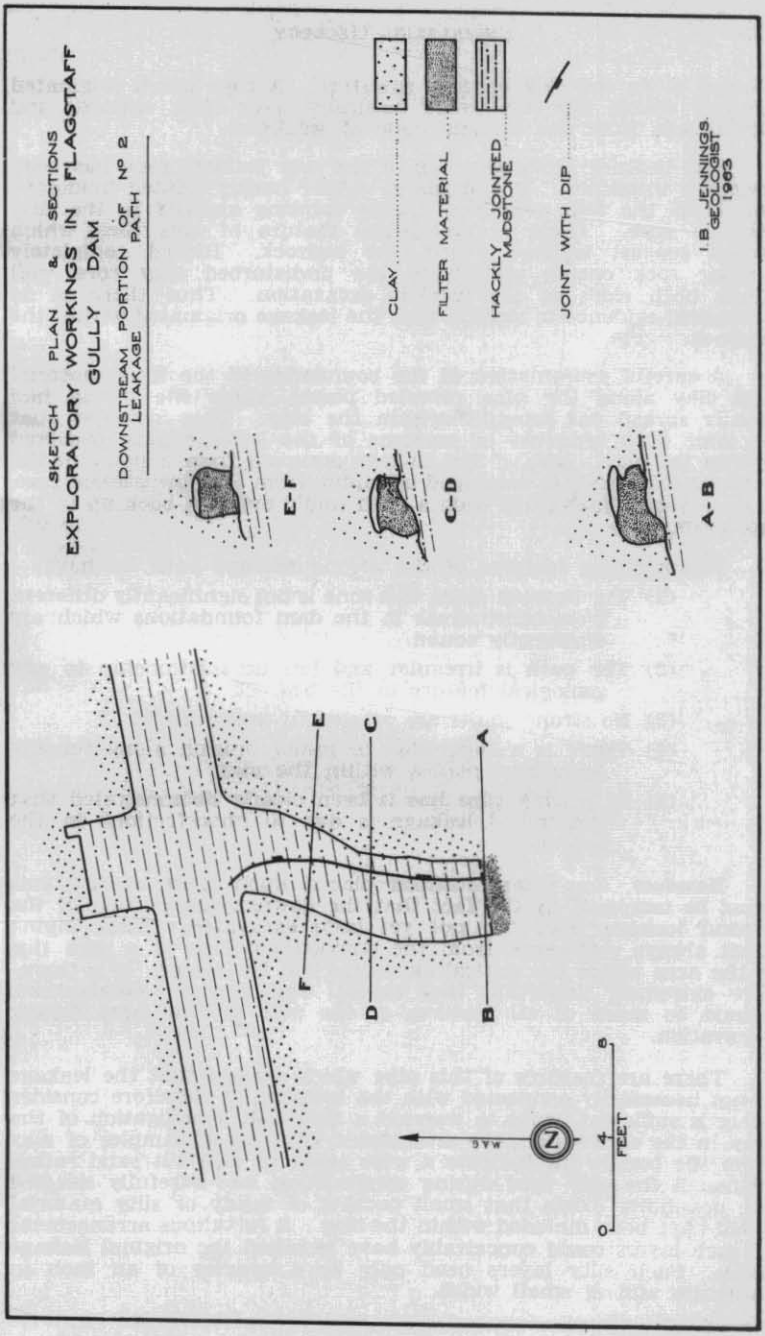

FIGURE 34.

5 cm

started along the clay/bedrock interface. A leak which originated entirely within the clay would naturally erode both upwards and downwards from the original zone of weakness.

The bedrock along the line of the new leakage zone has been carefully examined. It consists of rather hackly jointed mudstone but lacks the well developed master jointing exposed in the first leakage pipe. There is no special feature of this rock which would suggest leakage within the bedrock. Indeed completely similar rock occurs underlying the undisturbed clay core wall along both sides of the present excavation. Thus there is no geological evidence to suggest that the leakage originated within the bedrock.

A careful examination of the boundaries of the filter material and clay along the pipe revealed places where the piping had locally spread out laterally within the clay. This indicates that at some time branches or portions of the leakage path occurred within the clay. Also, if the leakage occurred from a point in the foundation rocks and developed by piping from the downstream face, then it seems doubtful if such a path would ever cut back up to the upstream face.

Summarizing features of the second leakage path we have:—

(1) The bedrock along this zone is not significantly different from other areas in the dam foundations which are apparently sound.

(2) The path is irregular and has no relationship to any geological feature in the bedrock.

(3) No strong joints are present in the bedrock.

(4) There is a suggestion of minor erosion along roughly horizontal planes within the clay.

(5) In neither case has it been clearly demonstrated that the initial leakage is due to imperfections in the bedrock.

However, any interpretations placed upon these observations must be tempered by the fact that the downstream portion of the second leakage path has not yet been excavated. Since piping must always commence from the downstream face of a dam this is the area where the critical exposures will be located. It is therefore extremely important that careful and accurate observations should be made of all features of the pipe in that area during excavation.

There are features of this pipe which suggest that the leakage is not necessarily connected with the bedrock. I therefore consider there is sufficient doubt to warrant a thorough investigation of the clay in the core wall. The mechanical analyses of samples of clay from the borrow pit indicate a wide range of clay-silt/sand ratios. Although the clay used during construction was carefully selected the possibility exists that small pockets of sandy or silty material could have been included within the clay . A fortuitous arrangement of such layers could conceivably have localized the original leakage paths. Such silty layers need only be a quarter of an inch in thickness and of small width.

The only mechanical analyses available are of bulk samples or of samples over a foot or more in width. The results of such samples would indicate the bulk characteristics of the clay and would not show minor variations due to layers which are probably less than one inch in thickness.

It is therefore recommended that a series of samples be taken each representing only a few inches of the clay core and mechanical analyses be made of these. If they disclose any significant variations in the clay-silt/sand ratios then further detailed sampling should be undertaken. Ideally such samples should be taken from a series of large diameter cores drilled, or driven, vertically through the core wall.