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GEOLOGICAL SURVEY

GOLD RESOURCE POTENTIAL OF THE DENALI BENCH GRAVELS, ALASKA

By

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This report is preliminary and has not been edited or reviewed for conformity with U. S. Geological Survey standards or nomenclature.

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ABSTRACT

Recent investigations of the Denali bench gravels near Denali, Alaska, including seismic refraction measurements, have defined a deposit of gravel containing approximately 35,000,000 cubic yards of auriferous material. Nearly a square mile in area and averaging 45 feet or more in thickness, it extends north and south of the present Valdez Creek. Sample data obtained from private sources and previous work indicate that gold values, computed at $35 per ounce, range from 50 cents to $1.20 per cubic yard and are distributed throughout the blanket. Although enrichments in bedrock depressions or incised channels have focused most previous mining efforts and would continue to play a supplementary role, the disseminated gold values in the gravels constitute the primary economic potential of the district. Potential resource value at 50 cents per cubic yard is in excess of $17,000,000.

INTRODUCTION

The Valdez Creek placer district was discovered in 1903 and has since been mined and explored intermittently up to the present. Gold production until 1936 was estimated at $1,250,000 (at $35 per ounce), nearly all of which came from placers (Tuck, 1938, p. 113).

During 1968-69 the area was reexamined as part of the U. S. Geological Survey's Heavy Metals Program. This brief report considers only the placer deposits near the abandoned town of Denali and integrates earlier published information with new seismic refraction data to give resource estimates for the gold bearing gravels.

The Denali placer area is located approximately midway between the towns of Paxson and Cantwell, Alaska, near the confluence of Valdez Creek with the Susitna River. It lies 5 miles north of the Denali Highway and is accessible via an unimproved road that joins the highway near milepost 77. Two unimproved airstrips in the area are also accessible to light aircraft (fig. 1).

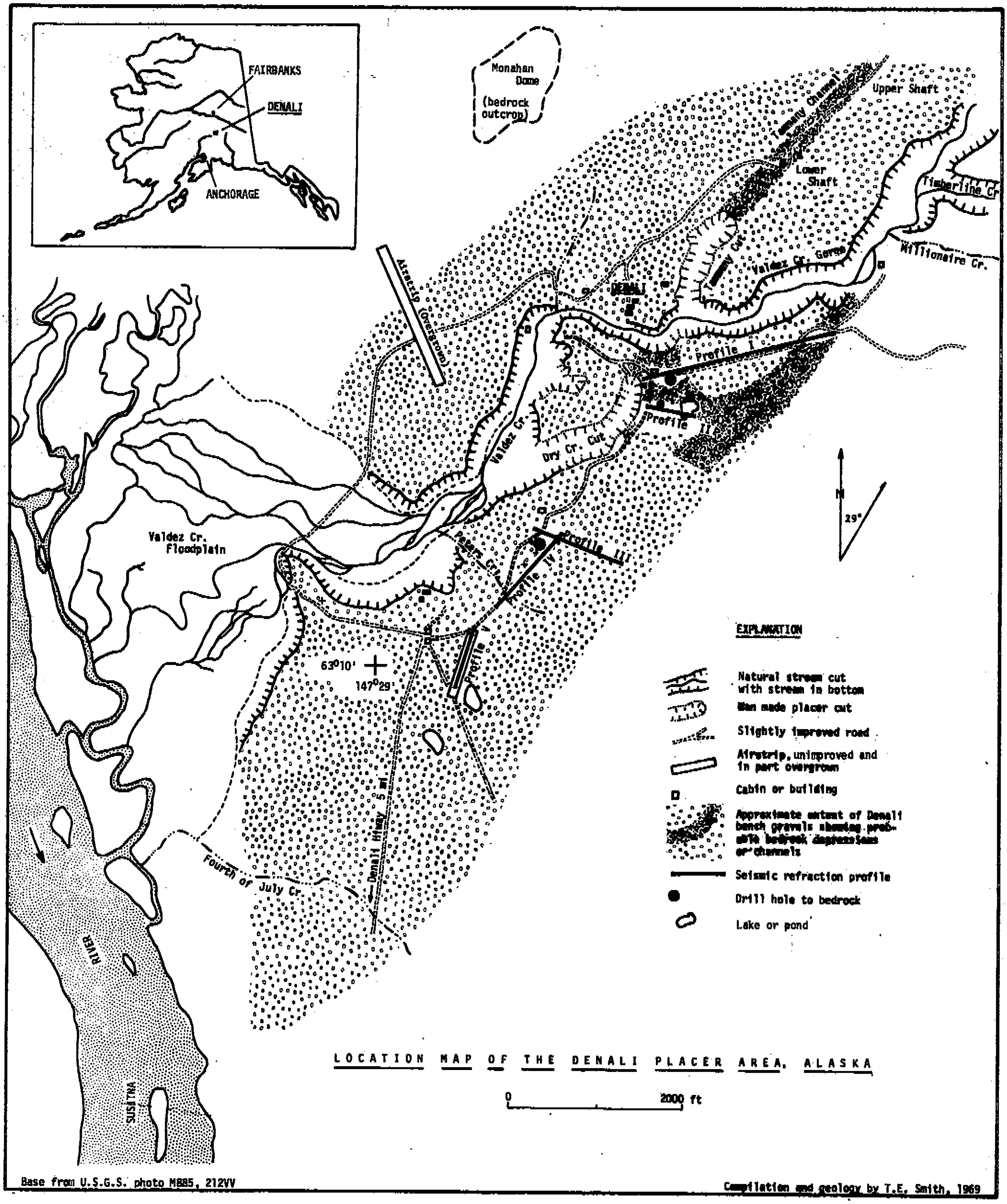

Figure 1. Index map of the Denali placer area, Healy A-1 quadrangle, Alaska.

GEOLOGY

Bedrock

The Denali bench gravels are underlain by metamorphic rocks that are gradational from dark gray argillite and greenish graywackes at the south end of the area to dark lineated phyllites north of Denali. Locally, interbed shearing and minor folding has produced slaty cleavage within both phyllites and higher grade argillites. In the extreme northern end of the map area, the phyllites are distinctly spotted with clots of poikiloblastic biotite.

The gradational bedrock sequence lies in the lower grade part of a regional metamorphic terrain. Bedding and foliation attitudes dip gently northward across the area, but are complicated locally by small scale folds and numerous faults. The metamorphic zonation is important to the present study because seismic velocity varies with the degree of recrystallization. Slight velocity differences along profiles may also in part reflect varying attitudes of metamorphic foliation.

Gravel Deposits

The Denali bench gravels, as discussed and informally named in this report, include both the auriferous alluvium on the bedrock bench adjacent to Valdez Creek and local channel fillings deposited in incised cuts within the bench. The deposits are distributed in a broadly curved belt extending northeast and southwest of the present Valdez Creek (fig. 1).

Early mining activity and geology of the previously active deposits has been discussed by Moffit (1912), Ross (1933), and Tuck (1938). The reader is referred to these reports for more complete information on the early history of the district.

Mining efforts in the gravels surrounding Denali were mainly concentrated along a deeply incised bedrock canyon cut by the ancestral Valdez Creek and later filled with auriferous gravels. This buried canyon — called the Tammany Channel — and its downstream extension, the Dry Creek Cut, were filled by moderately sorted fluvial gravels, since removed by hydraulic mining activity. Local concentrations of subrounded boulders are common near the channel bottom, and quartz diorite, schist, and argillite represent the most abundant lithologies in the gravels. In underground workings driven along the channel bottom north of the Tammany Cut, a thin layer of decomposed phyllite and slate bedrock yielded most of the values recovered (oral comm., J. Herman, 1969), although all of the fill is reported to contain fine gold (Ross, 1933, p. 450). Scour-and-fill structures are prevalent in the lower part of the channel, but give way to evenly bedded material near the top. Numerous, discontinuous horizons of rounded or subrounded cobbles are present throughout the gravels. All detritus appears to be derived from the Valdez Creek drainage; no exotic lithologies suggest that glacial debris from other drainages has been incorporated in the deposits.

In addition to the channel fillings, a broad blanket-like deposit of well-bedded, auriferous gravels extends over the Denali area away from the ancestral and present Valdez Creek. Several mining operations since 1940 have been sustained by gold distributed throughout this blanket, e.g., in the south wall of Valdez Creek across from Denali (fig. 2) and near Peters Creek.

The V-shaped cross-section and large rounded boulders in the buried channel record a period of vigorous erosion - perhaps during an early Pleistocene interglacial stage. Downcutting during this time was to a

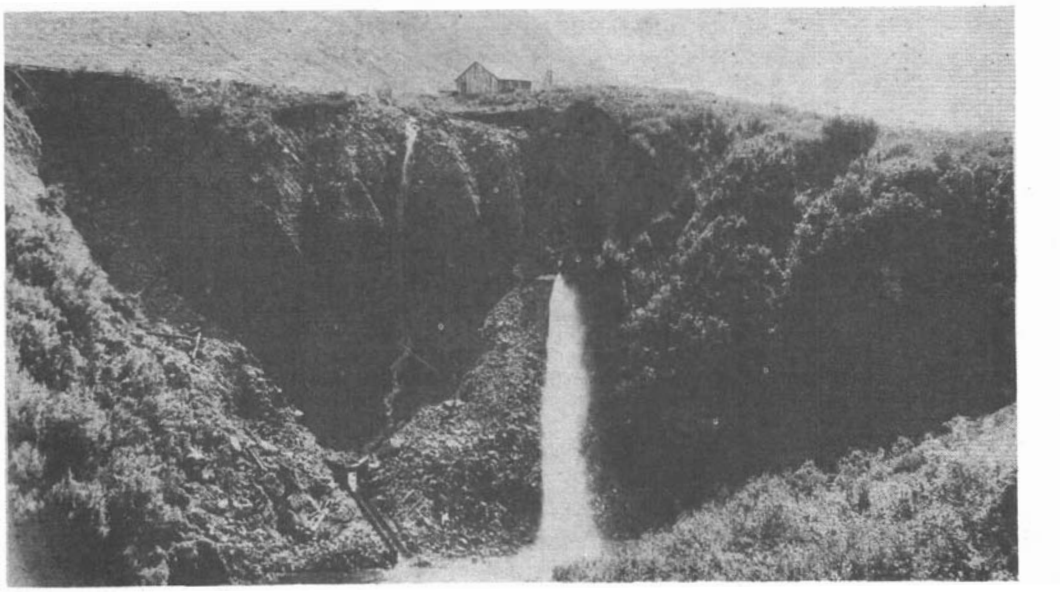

Figure 2. Placer cut in bench gravels, looking south across Valdez Creek from Denali. (Photo taken in 1946, courtesy of L.B. Kercher.)

base level near the present Susitna Valley. A subsequent local raise in base level, probably attributable to an advance of the Susitna glacier, initiated a long period of aggradation during which the canyons were filled and surrounding benches covered by bedded fluvial gravels. Within the gravels, a general absence of scour-and-fill structures except in the deeper channels, distinct bedding, dips lower than two degrees, and lack of bedding relation to the irregular bedrock surface all suggest moderate energy deposition on a gentle alluvial plain. In view of their areal configuration parallel to the Valdez Creek Valley and their internal character, the author interprets the gravels as a broad proglacial outwash deposit or valley train below the stationary or retreating terminus of the Valdez Creek glacier. The western side of the aggradational outwash plain was apparently bounded and obstructed by the Susitna Valley glacier, deflecting the proglacial deposits southward along the mountain front.

A final advance and rapid retreat of the Valdez Creek glacier has mantled the outwash plain with a thin, irregular ground moraine complex containing abundant angular boulders of lithologies indigenous to the Valdez Creek basin. The morainal complex is rarely more than ten feet in thickness, although locally its surface is undulatory and marked by numerous low ridges and potholes, whose vertical relief also is on the order of ten feet. This heterogeneous unit, which makes up the present surface, is the greatest source of difficulty in obtaining seismic records from the area.

A rejuvenation of Valdez Creek, initiated by withdrawal of the Susitna glacier and simultaneous lowering of base level, has resulted in the deep gorge through which the present creek flows -- approximately 20 feet lower than the floor of the ancestral creek, now exposed in the Tammany Cut.

SEISMIC REFRACTION STUDIES

Methods of Data Collection

A limited number of shallow refraction measurements were made during 1969 to aid in estimating the total volume of gravel present on the Denali bench and to determine whether other buried channels, comparable to the Tammany channel, have been eroded into the bench nearer the mountains. The locations of profiles shot in the present study are shown on figure 1.

Seismic data were collected using an Electro-Tech 12-channel portable refraction unit. The PRA-2-12 amplifier bank, SDW-100 oscillograph and power supply were mounted in an enclosed, tracked vehicle, providing off-road capability in locating the profiles. Twelve 4.5 cps geophones (EUS-8) were placed at 50 foot intervals along all spreads shot in the current study.

In order to minimize near-surface velocity variations in thawed swamps and morainal debris, the data were recorded in late May before active-zone ground ice had thawed below a few inches. With few exceptions, all geophones were emplaced directly in the frozen surface layer. A satisfactory acoustic coupling was obtained by similarly placing all shots in holes dug into the frozen layer or in shallow ponds on the frozen surface. Energy sources used were standard 40% dynamite and varied from one to eight sticks depending on record quality and offset distance to the spread. All profiles were reversed and, with the exception of Profile V (fig. 4), were shot at least twice in the same direction from different offsets; this technique provided the necessary redundancy for establishing bedrock velocities and local departures from linear time-distance curves.

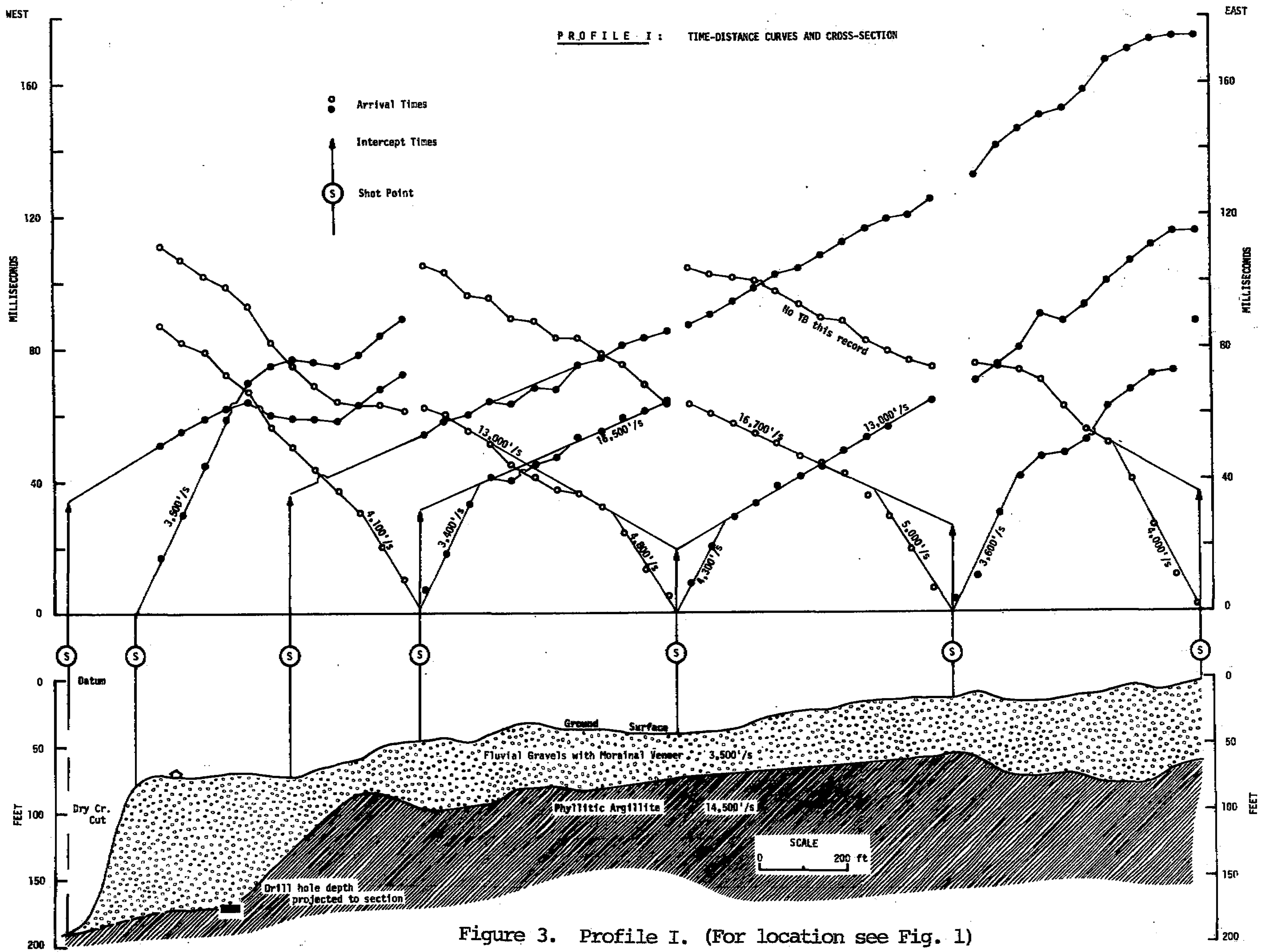

Figure 3. Profile I. (For location see Fig. 1)

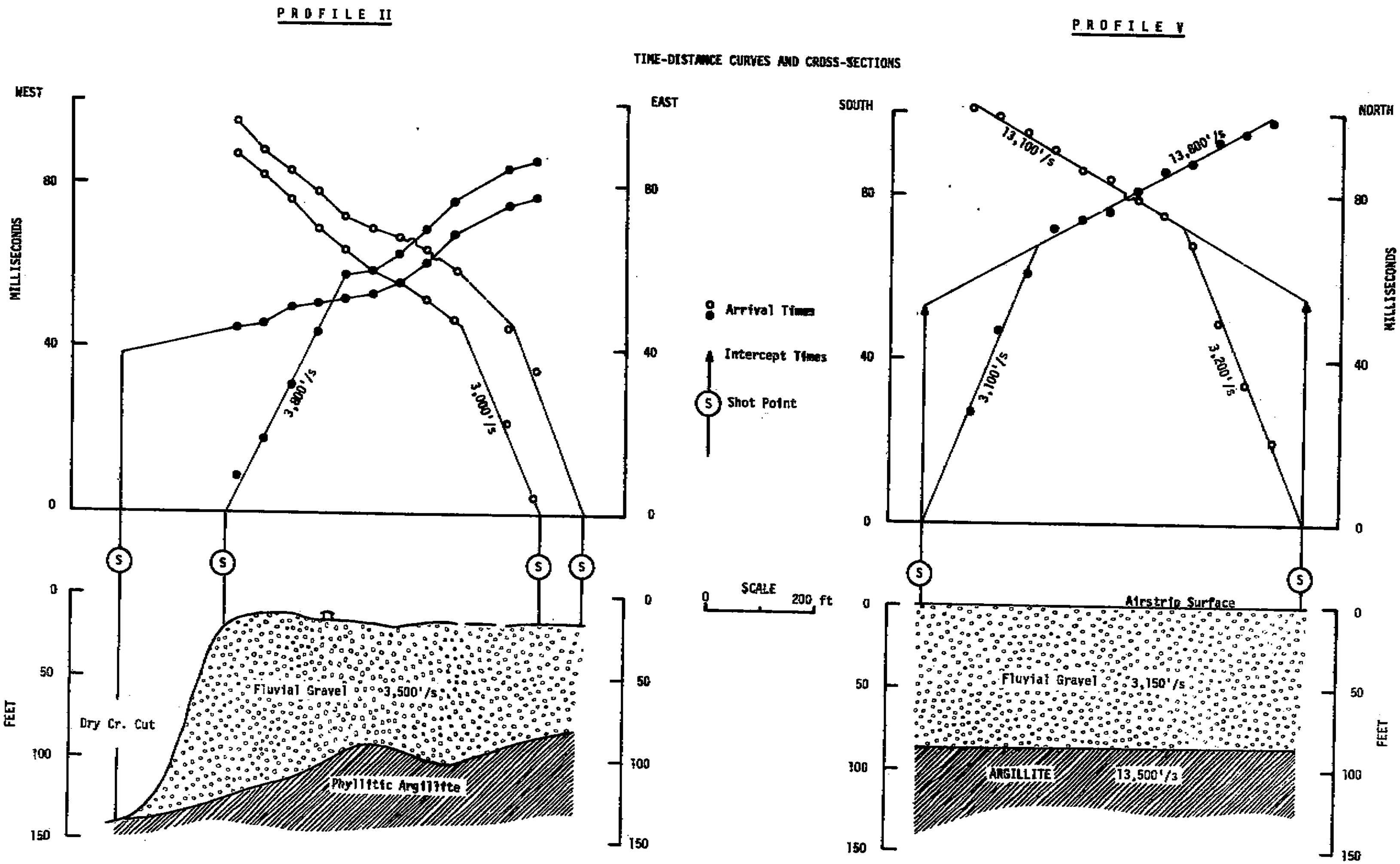

Figure 4. Time-distance curves and cross-sections, Profiles II and V.
(For location see Fig. 1)

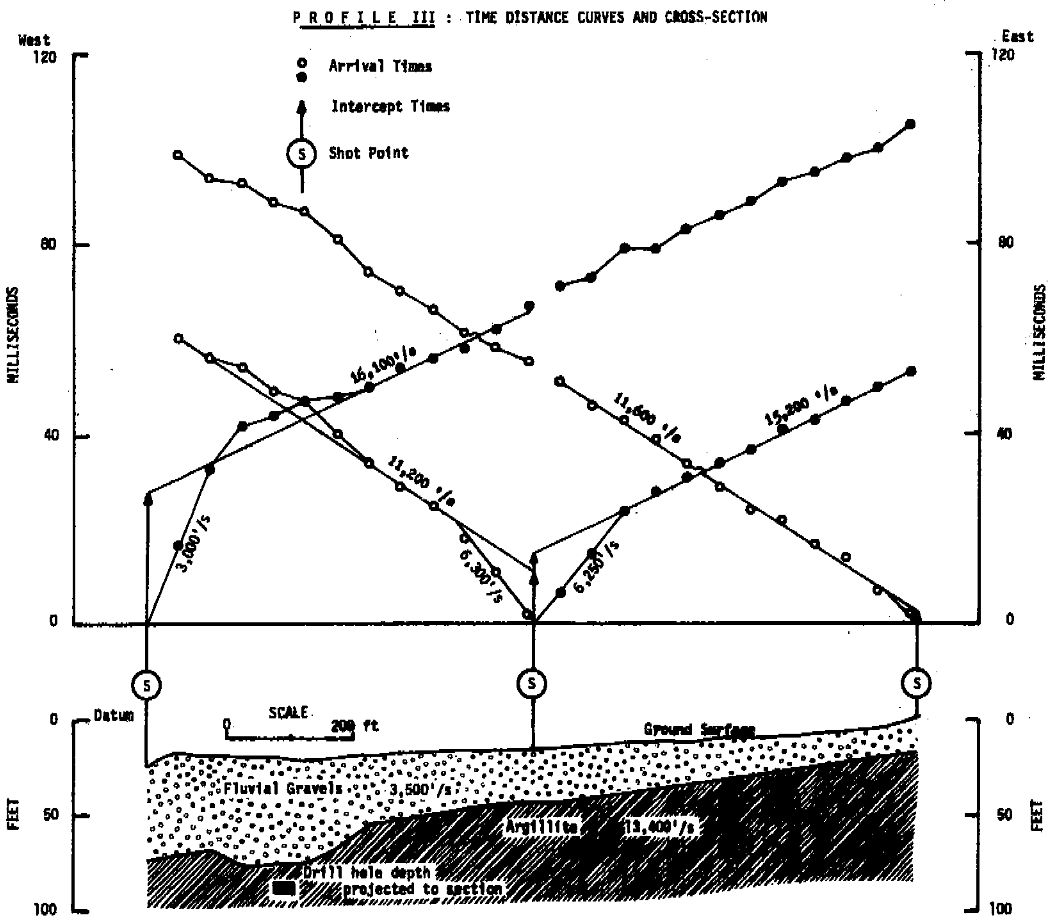

Figure 5. Time-distance curves and cross-section, Profile III. (For location see Fig. 1)

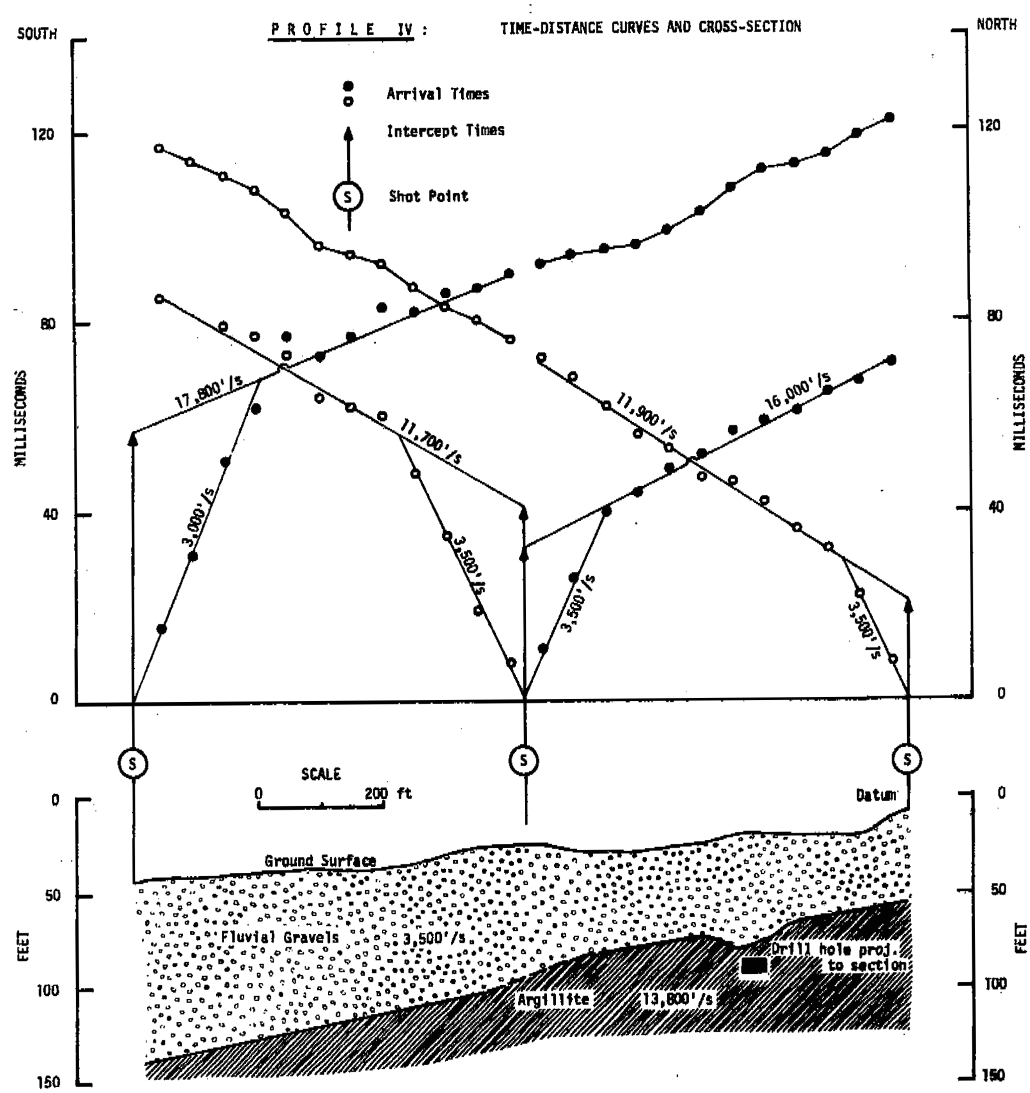

Figure 6. Time-distance curves and cross-section, Profile IV. (For location see Fig. 1)

Wherever possible, as at the west end of Profiles I and II, shots were placed directly on bedrock in old placer cuts, thus allowing a direct comparison of computed and actual gravel thicknesses. Two drill holes shown on figure 1 provide additional control on interpretations.

Interpretation

Geologic cross-sections inferred from the time-distance curves are shown in figures 3 to 6. On all reversed profiles permitting a good estimate of suballuvial velocities, the standard time-intercept method (discussed by Dobrin, 1962, p. 82) was applied to establish the planar bedrock model shown. Only the innermost data between shot points were utilized in these computations; redundant information from greater offsets was used merely as a check on correct choice of suballuvial velocities and on local variations from the linear model. After the data were corrected for surface topography (plotted only on inner data actually used), all departures from a linear travel-time curve were interpreted as variations of the bedrock surface. These are shown as undulations in the basic planar models.

On the end spreads of Profile I and on Profile II, the data do not permit a good choice of travel-time slope. These spreads were interpreted using the method-of-differences (Jakowsky, 1961, p. 725) corrected for appropriate critical propagation angles. The solutions so obtained accord well with adjacent planar solutions.

Seismic velocities in unfrozen protions of the gravel blanket vary from 3,000 feet per second to 3,800 feet per second. The presence of a thin frozen layer complicates to some extent the choice of a representative velocity for the gravels, and creates a corresponding element of ambiguity in the interpretations. In water-saturated swamp material, the first energy arrived at a velocity characteristic of the frozen surface, e.g., 6,300 feet per second in the center of Profile III. However, in the better drained areas, as along Profile I, the frozen layer velocities varied between 3,500 and 5,000 feet per second depending on content of ground ice. An average lower velocity of 3,500 feet per second is observed along all profiles except in well drained areas in the extreme south; this is interpreted as characteristic of the thawed ground. Computational models obtained assuming this velocity are in reasonable agreement with drillhole data (personal comm., M. Wall and L. Kercher, 1969) and with outcropping bedrock in the cuts.

The ambiguity arises in the central part of Profile III, where the velocities in the frozen surface cannot be distinguished from similar effects produced by a permafrost model. If the gravels were entirely frozen, the solution would require the bedrock to be deeper than shown in order to satisfy the higher velocity, thus doubling the total amount of gravel estimated for this part of the bench. In spite of this ambiguity, a number of factors exist which lessen the probability of permafrost lenses in the gravels. They are: (1) solutions to the data which use the high apparent surface velocity place bedrock much deeper than available drill results would indicate, (2) no time differential occurs between the area of possible permafrost and thawed 3,500 feet per second material near the west end of Profile III, (3) similarly, no change of bedrock velocity is observed between the area in question and the thawed region, and (4) the area of possible permafrost is relatively dry between rainfalls in late summer; a permafrost lens would be expected to contribute meltwater throughout the dry season. In view of these observations, interpretations in this region of ambiguity assume a gravel velocity of 3,500 feet per second.

Any further attempts to apply seismic methods to the bench gravels, as for example in support of an exploration program, should include a comprehensive evaluation of surface velocities. Such a survey could be conducted with a portable seismic unit in the late summer season, after seasonal ground ice has melted. With the resulting velocity control at hand, a very accurate compilation of bedrock configuration might be obtained using the techniques and timing of this investigation.

An inspection of the inferred cross-sections shows that the Denali bench is a relatively smooth bedrock surface. Gentle undulations and shallow depressions characterize its relief rather than deeply incised channels such as the Tammany Channel. Deposits along the Dry Creek Cut are the deepest present on the bench. Profiles I and II reveal that mining operations in the cut did not extend to the edge of the channel; a considerable volume of channel fill still exists at this location. Elsewhere, the bench is mantled with a blanket of gravel, averaging in thickness from 45 feet in the north to near 75 feet in the south. These general thicknesses are in good agreement with observations along the Valdez Creek gorge and with available drill hole data.

Gold Values in the Gravels

Several methods may be applied in assessing the bulk value of a deposit such as that on the Denali bench. Perhaps the best estimates of value are those reported by Ross (1933, p. 451) for the older workings. Until 1931, placer operations in the Tammany Channel had processed approximately 500,000 yards of material, yielding some 6,750 ounces of gold or $236,000 (at $35 per ounce). An average value for all gravel, including the bedrock concentration was about $1.10 per cubic yard.

Ross also reports that on the south side of Valdez Creek, downstream from Denali, the processing of 100,000 cubic yards of bench material produced 2,850 ounces of gold, excluding that in the sluice boxes at the time of his examination. His estimate of bulk value, computed to present price of gold, is near $1.20 per cubic yard.

More recent estimates have been made for the gravels near Peters Creek (see fig. 1). There, complete panning of a vertical channel sample, totalling about 16 cubic yards, gave an average value of 50 cents per cubic yard, with little variation throughout the blanket (personal comm., L. B. Kercher, 1969).

A drill hole to bedrock near Profile III suggested also that gold is distributed uniformly in the gravels and averages about $1.27 per cubic yard, although some allowance should be made for inadvertent "salting" in the open hole (personal comm., M. J. Wall and L. B. Kercher, 1969).

During the present investigation, numerous small samples were panned from various vertical cutbanks in the gravels. Small amounts of gold, visible to the eye, were found in all of these samples except those taken at the very top of the gravel blanket. In view of the very small quantity of sample taken at each locality, these results cannot provide an estimate of bulk value. They do however verify the extensive distribution of gold throughout the gravels.

A conservative estimate of total worth may be extended to the entire blanket using the lowest value outlined above and minimum indicated dimensions of the gravel deposit. An inspection of figure 1 shows that the areal extent of the blanket is at least 3,000 feet by 7,000 feet. Using these dimensions and the minimum thickness of 45 feet implied by the seismic measurements, a conservative volume of 35,000,000 cubic yards of auriferous detritus may be inferred to cover the Denali bench. At 50 cents per cubic yard, a resource value of $17,000,000 in gold is implied for the Denali bench gravels. This figure is based on physical measurements and sample data taken in a limited area near previous placer operations and thus, must be considered a potential estimate. Further exploration efforts are needed to verify that the bulk values implied by this study extend over the entire gravel deposit.

CONCLUSIONS

The recent studies summarized in this report and the integration of older data suggest that significant quantities of disseminated placer gold may be present in the extensive gravel deposits near Denali. Within the past 30 years, attempts to mine the deposits have been frustrated by property fragmentation and physical difficulties such as the presence of boulders within the gravels. Newer techniques of exploration and modern technology in handling bulk placers are needed in order to achieve success in future exploitation of the deposits.

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