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COMMONWEALTH OF AUSTRALIA
DEPARTMENT OF NATIONAL DEVELOPMENT
BUREAU OF MINERAL RESOURCES,
GEOLOGY AND GEOPHYSICS

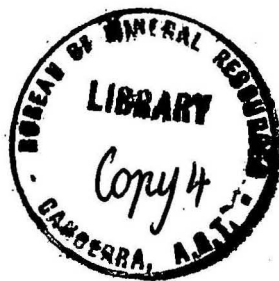
RECORDS 1956, N^o. 137

SEISMIC REFRACTION SURVEY OF
No. 2 DAM SITE AREA,
KIEWA, VICTORIA



by

W. A. WIEBENGA, D. F. DYSON and M. J. O'CONNOR



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CONTENTS

	<u>Page</u>
ABSTRACT	(iii)
1. INTRODUCTION	1.
2. GEOLOGY	1.
3. METHODS AND FIELD WORK	2.
4. RESULTS	2.
5. ACCURACY OF RESULTS	4.
6. CONCLUSIONS	4.
7. REFERENCES	5.

ILLUSTRATIONS

- Plate 1. Traverse plan and topography (Inset-locality map).
2. Profiles showing depths to unweathered rock.
 3. Contour map of unweathered rock.
 4. Isopach map showing thickness of overburden.

ABSTRACT

In response to an application from the State Electricity Commission of Victoria, a seismic survey was carried out over the Kiewa No. 2 Dam Site area to assist in finding the best location for a dam. The results of the seismic survey did not indicate any major faults in the dam site area, but showed that in places the depth of weathering exceeds one hundred feet. Based on the results of both seismic and drilling data, a recommendation is made as to the most suitable location for a dam site.

1. INTRODUCTION.

In response to an application from the State Electricity Commission of Victoria, a seismic refraction survey was made by the Geophysical Section of the Bureau of Mineral Resources over the Kiewa No. 2 Dam Site area.

The Kiewa No. 2 Development Scheme (Plate 1) consists of :-

- (i) No. 2 Dam, which will be supplied with water from the Pretty Valley Branch of the East Kiewa River, McKay Creek and the tail-race of No. 1 Power Station.
- (ii) No. 2 Head Race Tunnel, about $3\frac{1}{2}$ miles long, to divert this water to
- (iii) No. 2 Penstock Line, which leads to
- (iv) No. 2 Power Station to be built near the junction of the Pretty Valley and Rocky Valley Branches of the East Kiewa River at Bogong. The drop in water level from No. 2 Dam Site to No. 2 Power Station is about 1,300 feet.

No. 2 Dam Site area is located immediately below the junction of McKay Creek and the Pretty Valley Branch (Plate 1). The approximate co-ordinates of the centre of the area are 1358000N, 1560500E, on the grid of the 4-mile military map series.

In this report the term overburden is used to indicate material of low seismic velocity. This includes the weathered layer of the granodiorite or gneiss, alluvial deposits, soil and loose hill-side material.

The purpose of the survey was to find the most suitable location for a dam within the area. This necessitates an estimate of the thickness of the overburden, the location of any shear and fault zones and river terraces and, if possible, the determination of the nature of the overburden and of the unweathered rock.

The geophysical party consisted of D. F. Dyson, (party leader) and M. J. O'Connor, geophysicists, and J. P. Piggott, field assistant. Additional field assistants were supplied by the Commission. The field work was done during November and December, 1955 and March, 1956.

2. GEOLOGY.

Granodiorite crops out in, and adjacent to, the stream bed in the southern part of the area, as indicated on Plate 1. In the northern part of the area, landslips occur on both banks of the river and the stream bed widens into flats, composed of alluvium and slip debris.

The unweathered granodiorite is closely jointed, the majority of the joints being nearly vertical. The predominant strike of the joints is northerly, which coincides with the direction of the stream in the dam site area.

Isolated outcrops of gneiss occur. Where the gneiss is intersected in drillholes, the contact with the granodiorite is transitional.

2.

Downstream from where the 3,470 foot contour cuts the river, alluvial deposits overlies the basement rock (unweathered granodiorite) on the western side of the valley. The alluvial deposits are 25 feet thick in drill hole 877 (see Plates 2 and 4). In drill hole 879, 5 feet of alluvial deposits underlie hill side debris.

No major faults have been found in the area investigated, although the major "Frying Pan Fault" crops out immediately downstream. Many minor faults with a predominantly easterly strike have been found (Beavis, 1956).

3. METHOD AND FIELD WORK.

The seismic refraction method of survey was selected because from the results estimates of overburden thickness which are sufficiently accurate to be of practical use for engineering purposes, can be made.

The "method of differences" was used to calculate vertical travel times to the unweathered rock (Heiland, 1946 and Dyson, 1956). Difficulties were experienced in measuring reliable seismic velocities in the overburden. Vertical travel times calculated at points near diamond drill holes were therefore used to obtain apparent velocities in the overburden. The vertical travel time at each geophone, multiplied by the apparent velocity in the overburden at that point gives the depth to unweathered rock perpendicular to the surface at the geophone. In this manner the diamond drill hole information was used as a control for the seismic survey and not as a check on the accuracy of the seismic results.

A 12-channel Century 506 portable refraction seismograph was used, with T.I.C. geophones of natural frequency 20 c.p.s. Explosive charges with a maximum of 15 lbs. of 75 per cent gelignite were used, the exact amount depending on the depth of overburden at the shot point and on the distance to the geophone at the reciprocal shot-point.

The traverses, five in number, were cleared and surveyed by the Commission's Survey Section. Nine normal spreads and five weathering spreads were shot in the following manner:

(a) Normal Spreads: Eleven geophones were spaced at fifty-foot intervals along the slope of the ground, with shot points at the ends of the spread and at points sufficiently removed from each end of the spread to record refractions from the unweathered rock over the entire length of the spread.

(b) Weathering Spreads: Eleven geophones were spaced at ten-foot intervals along the slope of the ground, with shot points at 10, 50, 100 and 250 feet from either end of the spread.

4. RESULTS.

Profiles showing the seismic velocities recorded and the depth to unweathered rock calculated from the seismic results, are reproduced on Plate 2. The depths are plotted perpendicular to the ground surface.

The profile of the unweathered rock along traverse T-T' suggests the presence of terraces cut in the granodiorite between T15 and T22, and west of T28. This could not be confirmed from the drilling logs, however, as no cores were recovered from the upper portions of the drill holes in this vicinity.

3.

The profiles along traverses P-P', Q-Q' and R-R' indicate a general increase in the thickness of the overburden towards the north.

Seismic velocities usually give a fairly good indication of rock type, but to make a definite interpretation a certain amount of geological control is needed. Usually, it is possible to compare drill log descriptions of rock type with the seismic velocities, but in the present survey the descriptions on the drill logs were not always adequate.

Table 1 gives a probable interpretation of the seismic velocities recorded, in terms of rock type.

TABLE 1.

Velocity of Longitudinal Waves (ft/sec.)	Rock Type
1,200 - 1,700	Soil
2,900 - 4,500	Completely weathered granodiorite or gneiss and perhaps alluvial deposits.
5,000 - 7,400	Weathered and fractured granodiorite or gneiss.
10,000 - 11,000	Sheared or fractured granodiorite or gneiss, probably slightly weathered along fractures.
15,000 - 17,500	Unweathered granodiorite or gneiss, probably slightly jointed or fractured.
19,000 - 22,000	Unweathered, unbroken granodiorite or gneiss.

Plate 3 is a contour map of the unweathered rock, compiled from the profiles shown on Plate 2 and the available drill hole information. The main features of the map are:-

- (i) A pronounced ridge of unweathered rock with north-easterly strike on the western bank of the Pretty Valley Branch, near Q15.
- (ii) A depression in the unweathered rock, with an easterly strike, between P6 and Q4, which could be interpreted as a shear zone. This may explain why, when shooting from the southern end of traverse P-P', the transmission of energy of the sound wave through the ground was poor towards the north.
- (iii) A depression in the southern part of the area, coinciding roughly with the Pretty Valley Branch, is indicated by contours 3480 to 3520.
- (iv) On the eastern bank, the contours indicate a depression in the unweathered rock near S11. The presence of a nearby creek, flowing in the same direction as the strike of the depression, suggests that this feature may possibly be interpreted as a former gully (now in-filled) formed on a shear zone.

- (v) The closure of the contours round station T20 may possibly be interpreted as an indication of the remnants of a river terrace or a small "hill" on the general slope.

Plate 4 is an isopach plan showing the thickness of the overburden, as calculated from seismic and drilling data. The plan clearly shows that the overburden thickness decreases towards the river and may even be zero in the river bed.

5. ACCURACY OF RESULTS.

Errors are introduced into z , the calculated depth to fresh rock, by errors in the apparent velocity (v) and the vertical travel time (t).

$$z = v \cdot t.$$

Let the error in v and t be Δv and Δt respectively. Then the error, Δz , in z is given by :-

$$\begin{aligned}\Delta z &= (v + \Delta v)(t + \Delta t) - v t \\ &= t \Delta v + v \Delta t + \Delta v \Delta t.\end{aligned}$$

The third term, $\Delta v \Delta t$, is of a small order of magnitude and hence may be neglected.

$$\begin{aligned}\therefore \Delta z &= t \Delta v + v \Delta t \\ \text{i.e. } \frac{\Delta z}{z} &= \frac{\Delta v}{v} + \frac{\Delta t}{t}\end{aligned}$$

From velocity and drill hole data the term $\frac{\Delta v}{v}$ is estimated to be within ± 20 per cent.

The time measurements on the records indicate that, for an average depth of about 50 feet, the term $\frac{\Delta t}{t}$ does not exceed ± 5 per cent.

Hence the total accuracy of the depth measurements is within ± 25 per cent.

However, where the seismic traverses pass through drill hole sites, depths obtained from the seismic survey have been adjusted to depths obtained by drilling, and in such instances the accuracy of the depths indicated on the profiles (Plate 2) and isopach map (Plate 4) is considered to be much better than ± 25 per cent.

6. CONCLUSIONS.

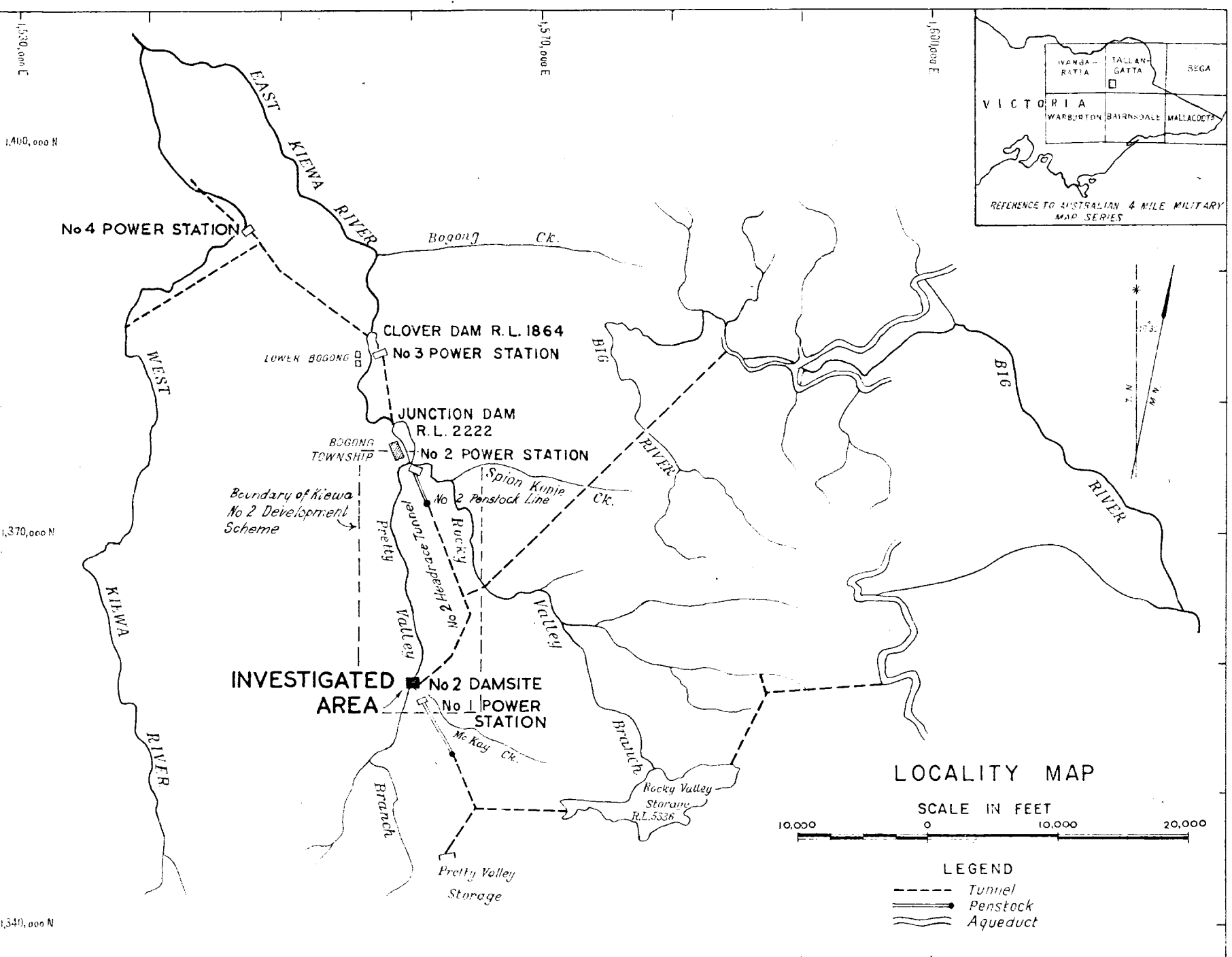
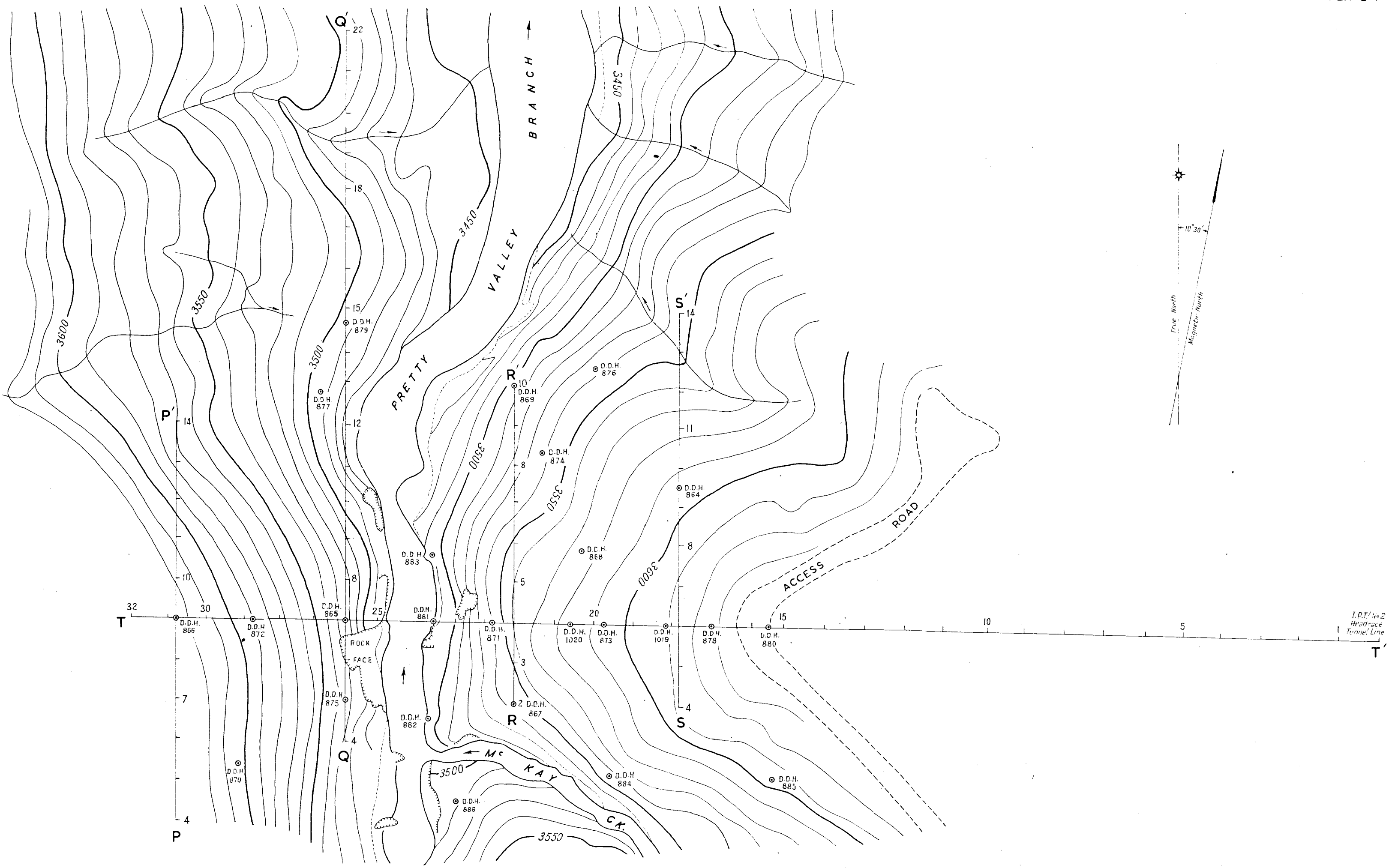
Seismic and drilling data show that the depth to unweathered rock is less along traverse T-T' than it is to the north and south of T-T'.

The seismic velocities in the unweathered rock between stations T6 and T14 indicate the presence of a shear zone within these limits.

It is considered that the information obtained from the seismic survey will be of assistance in the selection of a dam site, and, should a site be selected within the area surveyed, may be useful in assisting with the design of the dam.

7. REFERENCES.

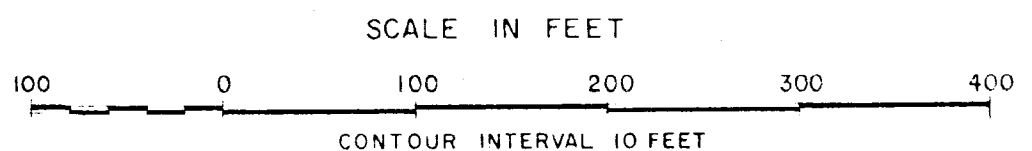
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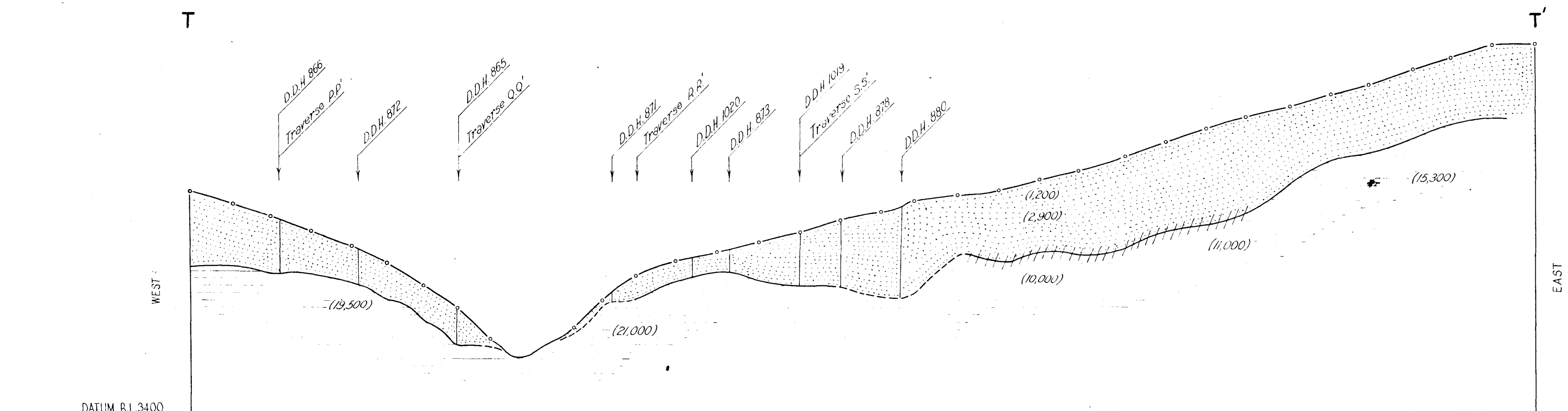
- LEGEND
- Traverse with stations
 - Surface contours (R.L. in feet)
 - Granodiorite outcrop
 - Main stream
 - Small creek
 - Top of river bank
 - Road
 - Diamond drill hole

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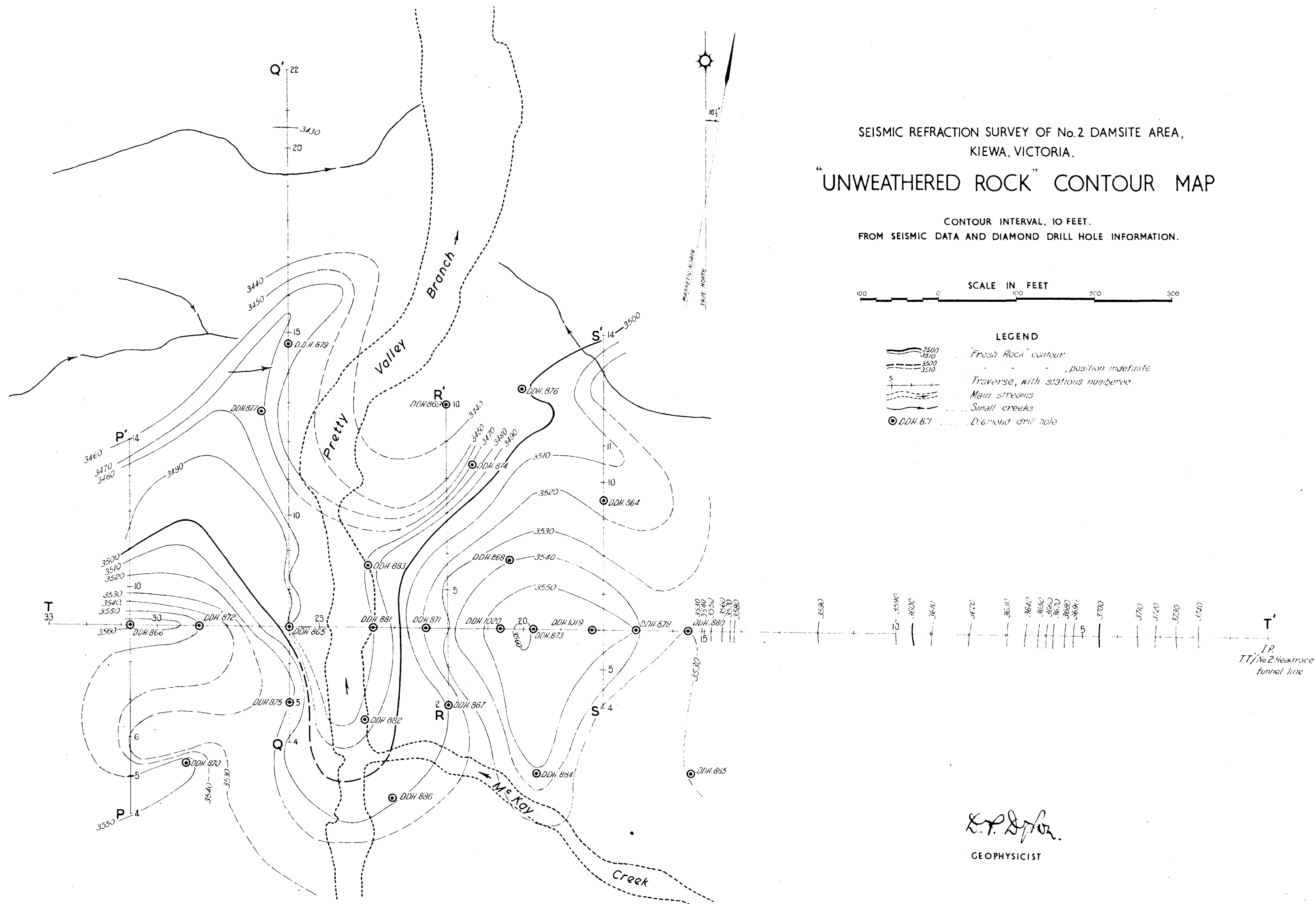
TRAVERSE PLAN AND TOPOGRAPHY



D. J. Dwyer
GEOPHYSICIST



STATION No.	733	732	731	730	729	728	727	726	725		722	721	720	719	718	717	716	715	714	713	712	711	710	709	708	707	706	705	704	703	702	701	700	699	698	697	696	695	694	693	692	691	690	689	688	687	686	685	684	683	682	681	680	679	678	677	676	675	674	673	672	671	670	669	668	667	666	665	664	663	662	661	660	659	658	657	656	655	654	653	652	651	650	649	648	647	646	645	644	643	642	641	640	639	638	637	636	635	634	633	632	631	630	629	628	627	626	625	624	623	622	621	620	619	618	617	616	615	614	613	612	611	610	609	608	607	606	605	604	603	602	601	600	599	598	597	596	595	594	593	592	591	590	589	588	587	586	585	584	583	582	581	580	579	578	577	576	575	574	573	572	571	570	569	568	567	566	565	564	563	562	561	560	559	558	557	556	555	554	553	552	551	550	549	548	547	546	545	544	543	542	541	540	539	538	537	536	535	534	533	532	531	530	529	528	527	526	525	524	523	522	521	520	519	518	517	516	515	514	513	512	511	510	509	508	507	506	505	504	503	502	501	500	499	498	497	496	495	494	493	492	491	490	489	488	487	486	485	484	483	482	481	480	479	478	477	476	475	474	473	472	471	470	469	468	467	466	465	464	463	462	461	460	459	458	457	456	455	454	453	452	451	450	449	448	447	446	445	444	443	442	441	440	439	438	437	436	435	434	433	432	431	430	429	428	427	426	425	424	423	422	421	420	419	418	417	416	415	414	413	412	411	410	409	408	407	406	405	404	403	402	401	400	399	398	397	396	395	394	393	392	391	390	389	388	387	386	385	384	383	382	381	380	379	378	377	376	375	374	373	372	371	370	369	368	367	366	365	364	363	362	361	360	359	358	357	356	355	354	353	352	351	350	349	348	347	346	345	344	343	342	341	340	339	338	337	336	335	334	333	332	331	330	329	328	327	326	325	324	323	322	321	320	319	318	317	316	315	314	313	312	311	310	309	308	307	306	305	304	303	302	301	300	299	298	297	296	295	294	293	292	291	290	289	288	287	286	285	284	283	282	281	280	279	278	277	276	275	274	273	272	271	270	269	268	267	266	265	264	263	262	261	260	259	258	257	256	255	254	253	252	251	250	249	248	247	246	245	244	243	242	241	240	239	238	237	236	235	234	233	232	231	230	229	228	227	226	225	224	223	222	221	220	219	218	217	216	215	214	213	212	211	210	209	208	207	206	205	204	203	202	201	200	199	198	197	196	195	194	193	192	191	190	189	188	187	186	185	184	183	182	181	180	179	178	177	176	175	174	173	172	171	170	169	168	167	166	165	164	163	162	161	160	159	158	157	156	155	154	153	152	151	150	149	148	147	146	145	144	143	142	141	140	139	138	137	136	135	134	133	132	131	130	129	128	127	126	125	124	123	122	121	120	119	118	117	116	115	114	113	112	111	110	109	108	107	106	105	104	103	102	101	100	99	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10	-11	-12	-13	-14	-15	-16	-17	-18	-19	-20	-21	-22	-23	-24	-25	-26	-27	-28	-29	-30	-31	-32	-33	-34	-35	-36	-37	-38	-39	-40	-41	-42	-43	-44	-45	-46	-47	-48	-49	-50	-51	-52	-53	-54	-55	-56	-57	-58	-59	-60	-61	-62	-63	-64	-65	-66	-67	-68	-69	-70	-71	-72	-73	-74	-75	-76	-77	-78	-79	-80	-81	-82	-83	-84	-85	-86	-87	-88	-89	-90	-91	-92	-93	-94	-95	-96	-97	-98	-99	-100	-101	-102	-103	-104	-105	-106	-107	-108	-109	-110	-111	-112	-113	-114	-115	-116	-117	-118	-119	-120	-121	-122	-123	-124	-125	-126	-127	-128	-129	-130	-131	-132	-133	-134	-135	-136	-137	-138	-139	-140	-141	-142	-143	-144	-145	-146	-147	-148	-149	-150	-151	-152	-153	-154	-155	-156	-157	-158	-159	-160	-161	-162	-163	-164	-165	-166	-167	-168	-169	-170	-171	-172	-173	-174	-175	-176	-177	-178	-179	-180	-181	-182	-183	-184	-185	-186	-187	-188	-189	-190	-191	-192	-193	-194	-195	-196	-197	-198	-199	-200	-201	-202	-203	-204	-205	-206	-207	-208	-209	-210	-211	-212	-213	-214	-215	-216	-217	-218	-219	-220	-221	-222	-223	-224	-225	-226	-227	-228	-229	-230	-231	-232	-233	-234	-235	-236	-237	-238	-239	-240	-241	-242	-243	-244	-245	-246	-247	-248	-249	-250	-251	-252	-253	-254	-255	-256	-257	-258	-259	-260	-261	-262	-263	-264	-265	-266	-267	-268	-269	-270	-271	-272	-273	-274	-275	-276	-277	-278	-279	-280	-281	-282	-283	-284	-285	-286	-287	-288	-289	-290	-291	-292	-293	-294	-295	-296	-297	-298	-299	-300	-301	-302	-303	-304	-305	-306	-307	-308	-309	-310	-311	-312	-313	-314	-315	-316	-317	-318	-319	-320	-321	-322	-323	-324	-325	-326	-327	-328	-329	-330	-331	-332	-333	-334	-335	-336	-337	-338	-339	-340	-341	-342	-343	-344	-345	-346	-347	-348	-349	-350	-351	-352	-353	-354	-355	-356	-357	-358	-359	-360	-361	-362	-363	-364	-365	-366	-367	-368	-369	-370	-371	-372	-373	-374	-375	-376	-377	-378	-379	-380	-381	-382	-383	-384	-385	-386	-387	-388	-389	-390	-391	-392	-393	-394	-395	-396	-397	-398	-399	-400	-401	-402	-403	-404	-405	-406	-407	-408	-409	-410	-411	-412	-413	-414	-415	-416	-417	-418	-419	-420	-421	-422	-423	-424	-425	-426	-427	-428	-429	-430	-431	-432	-433	-434	-435	-436	-437	-438	-439	-440	-441	-442	-443	-444	-445	-446	-447	-448	-449	-450	-451	-452	-453	-454	-455	-456	-457	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SEISMIC REFRACTION SURVEY OF No. 2 DAMSITE AREA,
KIEWA, VICTORIA.

ISOPACH MAP

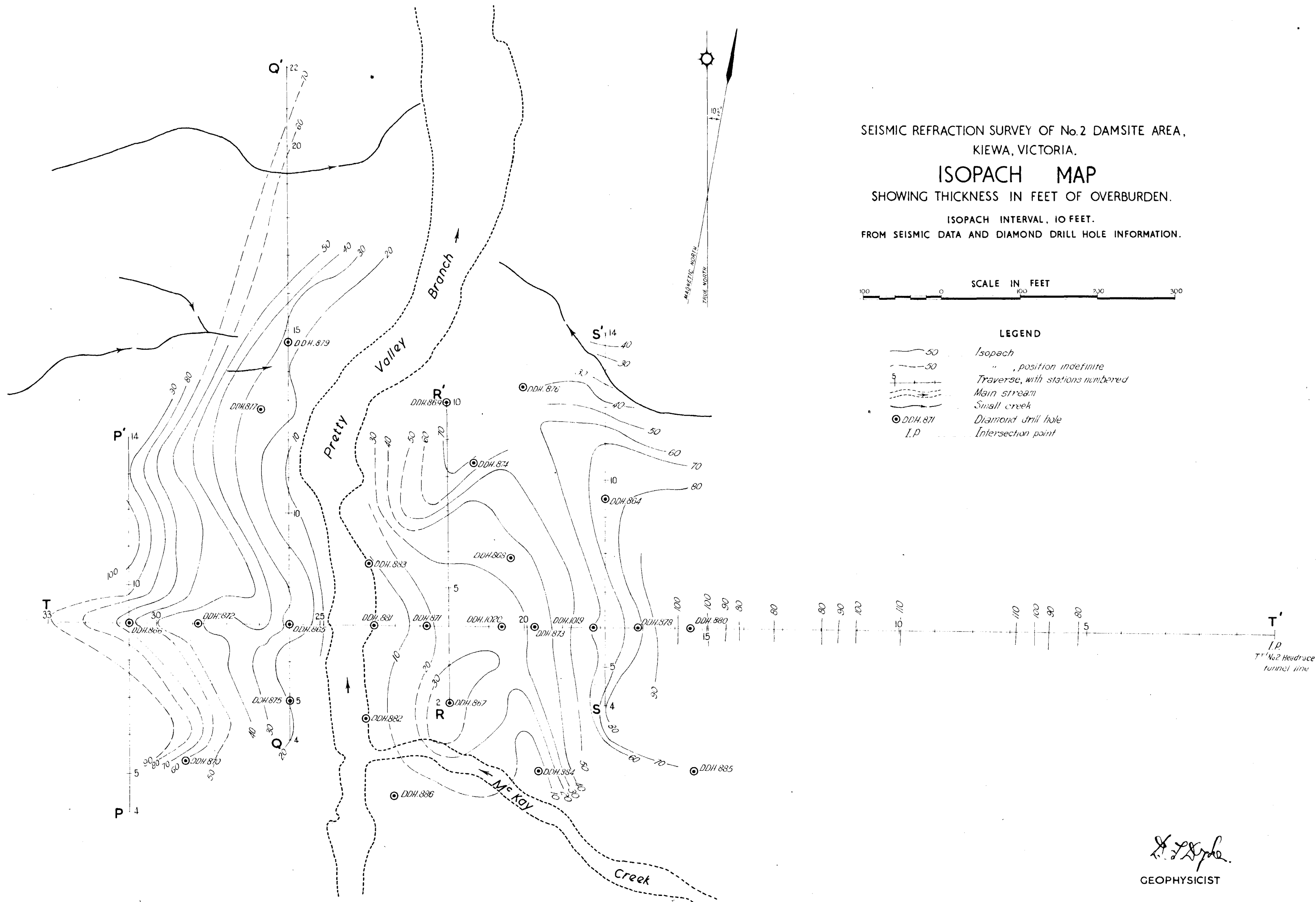
SHOWING THICKNESS IN FEET OF OVERBURDEN.

ISOPACH INTERVAL, 10 FEET.
FROM SEISMIC DATA AND DIAMOND DRILL HOLE INFORMATION.

SCALE IN FEET
100 0 100 200 300

LEGEND

- 50 — Isopach
- - - 50 - - - " , position indefinite
- 5 + + + Traverse, with stations numbered
- - - Main stream
- - - Small creek
- ⊙ DDH. 871 Diamond drill hole
- I.P. Intersection point



H. J. Dyke
GEOPHYSICIST