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PALAEOMAGNETIC MEASUREMENTS ON THE KEMPSEY BLOCK, N.S.W.

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SUMMARY

Palaeomagnetic measurements have been made on rock samples from the Kempsey Block, New South Wales, in order to determine if the Block has rotated. The measurements are preliminary and show that the palaeomagnetic method, though feasible, would be comparatively difficult to apply to this problem because of probable remagnetization of the rock by weathering, and because the inclination of the magnetization vector is large. Further work is recommended, but only if completely unweathered rock samples, preferably fine-grained red sediments, can be obtained.

1. INTRODUCTION

Palaeomagnetism has been employed successfully on several occasions in the past to determine relative rotational movements between portions of the Earth's crust, e.g. Kawai et al. (1961) and Clegg et al. (1957). This technique has been applied here to the Kempsey Block in northeastern New South Wales for which geological evidence indicates a possible large rotational movement during the Permian Hunter Orogeny. The magnetization direction of Upper Carboniferous rocks from a portion of the crust adjacent to the Kempsey Block but not affected by the rotation has been determined by Irving (1966) as 201°,+ 80°. This is taken as the reference direction for the measurements. The work was carried out on samples which were readily available but weathered, and is regarded as a preliminary investigation of the problem.

The palaeomagnetic samples were collected by Dr E. Scheibner and M. Burke (Geologists, Geological Survey, NSW) and Dr M. Idnurm (Geophysicist, BMR). Specimen preparation and measurements were carried out by M. Idnurm and R. Eaton (Technical Assistant, BMR). We wish to thank Drs B. Embelton (Australian National University) and P. Wellman (BMR) for useful advice, and The Research School of Earth Sciences, ANU, for permission to use their palaeomagnetic facilities.

2. GEOLOGICAL BACKGROUND

The Kempsey Block (Fig. 1) is part of the Tamworth Synclinorial Zone, and has a pattern of structural deformation and stratigraphy similar to the main portion of the zone around Tamworth and the Hunter Valley. The Block is bounded on three sides by major faults, which separate it from substantially different structural units: the Woolomin-Texas, Port Macquarie, and Nambucca Blocks. A series of faults separates it on the south side from the main Tamworth Synclinorial Zone. The main part of the Woolomin-Texas Block is composed of a mid-Palaeozoic trench complex (flysch wedge), and the Nambucca Block of a Permian trench complex. These trench complexes formed east of the Kempsey Block while the latter was a frontal arc area containing continental and unstable shelf tectonic regimes: Tamworth Frontal Arc Area, Mandowa Unstable Shelf, Kullatine Shelf and the Permian Yessabah Shelf (Scheibner, 1972, 1973, in press).

Concerning the tectonic history of the region, it has been postulated that the Peel Thrust which forms a boundary of the Kempsey Block is an obduction zone (Scheibner, 1972, 1973; Scheibner & Glen, 1972). Recent support for this theory comes from geological evidence from

Queensland (Murray, 1973; Green, 1973). It is assumed that the Peel Thrust was originally a slightly curved continuous arc located between the present Tamworth Synclinorial Zone and the Woolomin-Texas Block (and other similar blocks in Queensland). The major movement of the crustal blocks which occurred during the Permian Hunter Orogeny caused strike-slip displacements along most sections of the Peel Thrust. However north of the Hunter Valley horizontal telescoping of crustal blocks took place because of a collision between the Tamworth Synclinorial Zone, the Woolomin-Texas Block and the Nambucca Block. This caused radial block-fault tectonics in the area between Murrurundi and the coast (Geological Map of NSW, Pogson, 1972; Tectonic Map of NSW, Scheibner, in press). It is thought that during this brief episode of tectonic activity the Kempsey Block rotated anticlockwise coming into contact with the present Woolomin-Texas, Port Macquarie, and Nambucca Blocks (Fig. 1).

The hypothesis of Kempsey Block rotation is supported by sedimentological evidence from the late Carboniferous Kullatine Formation (Lindsay, 1969). This formation contains tilloid conglomerates comprising 7 percent of intrusive rock fragments, mostly pink granite and orthoclase porphyry. Turbidite and slump structures in the formation have suggested a southerly palaeoslope (Lindsay, 1966) which implies the existence of a source of granite to the northeast of the Kempsey Block. No pre-Permian granite is known to occur in that region. This difficulty is overcome on the rotational hypothesis if one assumes that the Kempsey Block was originally oriented in such a way that the clastics could be supplied from the foreland (Lachlan Fold Belt), or from uplifted blocks in the Hunter Valley area where Carboniferous granites do occur.

Possible alternative explanations for the source of pre-late Carboniferous granitic clasts are:

1. There was a source of granitic clasts to the northeast during the Carboniferous; this region separated from the continental mass during the opening of the Tasman Sea in the Cretaceous and now forms part of the Lord Howe Rise.

2. The source of the clasts was the Woolomin-Texas Block, from which the clasts were redeposited.

3. Undiscovered granites occur in the Woolomin-Texas Block.

3. SAMPLING

Samples were collected at eight sites (Fig. 2) along the northern boundary of the Kempsey Block; samples from two of the sites (3 and 4) were subsequently discarded because of fractures. The samples were sedimentary rocks mainly of the Upper Carboniferous Kullatine Formation (Lindsay, 1969). Table 1 lists the site locations and samples.

The samples were collected from roadcuts, road-fill quarries, and minor outcrops. Weathering is prevalent in the region and all sites were affected to some extent. A Brunton or, alternatively, a sun compass was used for sample orientation. Four samples were collected from Site 7, and three from each of the other sites. Two or more specimens were cut from each sample for measurement.

4. LABORATORY MEASUREMENTS

The measurements were made on a Princeton Applied Research spinner magnetometer at the Research School of Earth Sciences, ANU. The six-spin method of Doell & Cox (1967) was used in order to minimize errors. Measurements on an earlier set of test samples had indicated that red sediments (Sites 7 and 8) require thermal demagnetization to remove the unstable components, while the other samples require alternating-field demagnetization. This procedure was followed here, with additional thermal demagnetization checks on the alternating-field material. Because of the uncertain nature of the material all specimens were subjected to step-by-step demagnetization.

5. RESULTS

Table 2 lists the demagnetization results. The direction vectors of Sites 1, 5, and 6, and to a lesser extent 7, became constant during the treatments and remained constant till either the magnetic moments had become unstable or the intensities had fallen below the limits of accurate measurement. The direction vectors of Sites 2 and 8, however, failed to stabilize, and the results from those sites are therefore discarded.

The mean sample directions after appropriate demagnetization treatments are plotted in Figure 3; Figure 3A shows the present directions, Figure 3B the palaeodirections; site numbers are shown with the directions. The demagnetization levels in these plots were selected on the basis of minimum within-sample scatters and are as follows:

Site	Demagnetization
1	1200 Oerst.
5	200 Oerst.
6	200 Oerst.
7	300 °C

Site 7, though closely grouped in the present-direction diagram, shows a large within-site scatter when bedding-plane corrections are made to obtain the palaeodirection diagram. The failure of the bedding tilt test (Graham, 1949) suggests remagnetization, and this site is therefore discarded. The remaining three sites, 1, 5, and 6, satisfy palaeomagnetic criteria for sample suitability.

6. DISCUSSION

Despite the satisfactory demagnetization behaviour of Sites 1, 5, and 6, these results must nevertheless be regarded with caution because of the possibility of chemical remagnetization owing to weathering. In particular there is an increase in scatter in the palaeodirection diagram; however, it is small and is not sufficient evidence alone for remagnetization. We note that the age of the Kempsey Block samples lies in the Kiaman magnetic interval (Upper Carboniferous to Upper Permian), in which the polarity of the Earth's field was predominantly reversed (Valencio & Mitchell, 1972). Of the various sites examined only Site 8 shows a reversed polarity (i.e. positive inclination). As noted in Section 5 however, this site was discarded because its magnetization vector did not stabilize. There appears to be no test other than the measurement of completely fresh rock which would in this case remove uncertainty whether the rock has been remagnetized.

The inclination of the Earth's field at the Kempsey Block during the late Carboniferous and early Permian, when the sediments were deposited, has been found to be about 80° (Irving, 1966). The large inclination makes palaeomagnetic methods difficult to apply to this problem since it necessitates a high accuracy in the measurements to determine rotational movements of the Block. In particular, only unweathered material of comparatively large and stable remanence would give a reasonable chance of success. These conditions are best met in fine-grained red beds (Irving, 1964).

7. CONCLUSION

Sites 1, 5, and 6 satisfy the palaeomagnetic suitability criteria; the other sites were discarded. The results from the three palaeomagnetically satisfactory sites are, however, ambiguous because of probable remagnetization due to weathering. The present investigation shows that further palaeomagnetic work on the Kempsey Block should only be undertaken if unweathered rocks, preferably fine-grained red beds, can be obtained.

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TABLE 1 Sampling Data

Site	Grid Ref.	1:250 000 Sheet	Location	Lithology
1	539 153	Hastings	Roadcut	Lithic mudstone
2	539 153	Hastings	Roadcut	Lithic mudstone
3	544 168	Dorrigo	Roadcut	Siltstone
4	575 151	Hastings	Road-fill quarry	Siltstone
5	572 150	Hastings	Roadcut	Lithic siltstone
6	573 158	Hastings	Outcrop	Siltstone
7	572 159	Hastings	Roadside quarry	Red siltstone
8	574 157	Hastings	Outcrop	Red siltstone

TABLE 2. Demagnetization Results

Site	Sample	Specimen	Treatment	D	I	$Mx10^{-6}$ (emu/cc)
1	a	12	NRM	020	-81	2.5
			50 oerst.	017	-79	2.1
			100	351	-74	1.8
			300	323	-74	1.6
			800	307	-70	1.2
			1200	318	-74	1.0
			1700	348	-78	1.1
			2200	269	-63	0.5
1	a	222	NRM	314	-84	3.0
			50 oerst.	318	-78	3.2
			100	320	-77	2.9
			300	287	-73	2.5
			800	295	-74	2.5
			1200	310	-77	1.8
			1700	282	-75	2.0
			2200	263	-78	0.5
1	b	11	NRM	311	-83	2.8
			50 oerst.	343	-73	2.6
			100	350	-70	2.5
			300	353	-71	2.0
			800	359	-64	1.4
			1200	357	-73	1.8
			1700	352	-78	1.1
			2200	042	-26	0.7
1	b	21	NRM	244	-73	3.8
			50 oerst.	302	-79	3.3
			100	280	-75	3.1
			200	318	-77	2.8
			300	316	-77	2.6
			500	304	-78	2.5

Site	Sample	Specimen	Treatment	D	I	$Mx10^{-6}$ (emu/cc)
			800	316	-75	2.3
			1200	320	-77	2.2
			1700	341	-78	1.8
			2200	325	-77	1.3
1	b	51	NRM	302	-79	2.8
			50 oerst.	350	-74	2.7
			100	354	-71	2.5
			300	348	-72	1.9
			800	340	-75	1.6
			1200	324	-77	1.4
			1700	005	-64	1.1
			2200	016	-58	0.7
1	c	23	NRM	337	-87	4.0
			50 oerst.	335	-78	3.8
			100	333	-76	3.5
			300	315	-76	3.3
			800	310	-75	2.7
			1200	309	-75	2.2
			1700	342	-74	1.6
			2200	310	-76	1.1
1	c	22	NRM	037	-81	4.0
			50 oerst.	004	-76	3.7
			100	344	-73	3.4
			300	337	-74	3.0
			800	341	-78	2.6
			1200	352	-73	2.1
			1700	007	-79	1.9
			2200	338	-72	1.3
1	c	31	NRM	100	-85	3.7
			100°C	046	-84	3.2
			190°C	024	-83	2.7
			300°C	028	-81	2.1

Site	Sample	Specimen	Treatment	D	I	Mx10^{-6} (emu/cc)
			410°C	089	-51	0.5
			500°C	163	-79	0.3
			590°C	028	-52	0.7
2	a	11	NRM	078	-55	4.7
			50 oerst.	071	-58	3.1
			100	054	-57	1.6
			150	046	-62	0.9
			200	051	-51	0.7
			250	038	-45	0.5
			300	003	-9	0.2
			400	020	+33	0.2
			500	016	+30	0.2
2	a	12	NRM	083	-60	5.2
			50 oerst.	077	-61	3.7
			100	063	-59	1.8
			150	052	-59	1.0
			200	038	-60	0.8
			250	344	-51	0.3
			300	315	-53	0.3
			400	347	-17	0.2
2	b	11	NRM	031	+13	4.6
			50 oerst.	032	+8	3.2
			100	036	-8	1.4
			150	314	-38	0.7
			200	307	-50	0.6
			250	316	+29	0.1
			300	307	+51	0.1
			400	293	+39	0.2
2	b	12	NRM	300	+10	4.4
			50 oerst.	301	+7	3.3
			100	302	-9	1.4
			150	300	-34	0.8
			200	309	-55	0.5

Site	Sample	Specimen	Treatment	D	I	Mx10^{-6} (emu/cc)
			250	315	-67	0.5
			300	320	-67	0.5
			400	323	-53	0.2
			500	308	-75	0.5
2	b	21	NRM	298	+25	8.7
			100°C	299	+23	7.4
			190°C	299	+23	6.2
			300°C	299	+25	4.8
			410°C	299	+25	3.2
			500°C	296	+16	1.1
			590°C	034	-7	0.1
2	c	12	NRM	079	-69	3.9
			50 oerst.	085	-69	3.4
			100	056	-82	1.2
			150	358	-83	0.8
			200	343	-82	0.6
			250	328	-70	0.5
			300	300	-76	0.5
			400	277	-79	0.5
			500	281	-61	0.5
2	c	22	NRM	094	-77	3.5
			50 oerst.	078	-79	2.4
			100	006	-79	1.3
			150	355	-74	1.0
			200	326	-72	0.8
			300	005	-72	0.7
			400	311	-67	0.7
			500	293	-67	0.7
5	a	11	NRM	298	-63	2.0
			25 oerst.	301	-63	1.9
			50	305	-62	1.7
			100	302	-63	1.4

Site	Sample	Specimen	Treatment	D	I	Mx10^{-6} (emu/cc)
			150	301	-66	1.1
			200	294	-69	0.9
			250	295	-63	0.7
			300	264	-58	0.5
			350	271	-43	0.5
			400	279	-47	0.4
5	a	21	NRM	328	-72	2.5
			50 oerst.	322	-73	2.3
			100	326	-71	2.0
			200	307	-69	1.4
			300	306	-63	1.1
			400	307	-76	0.6
5	a	31	NRM	330	-75	3.1
			50 oerst.	328	-73	2.6
			100	320	-75	2.2
			200	316	-75	1.5
			400	045	-86	0.6
			500	068	-79	0.5
5	b	11	NRM	309	-60	2.2
			50 oerst.	312	-56	1.8
			100	313	-52	1.6
			150	307	-58	1.3
			200	304	-51	1.1
			250	304	-53	1.0
			300	301	-73	0.7
			400	310	-63	0.3
			500	306	-19	0.9
5	b	21	NRM	322	-69	2.3
			50 oerst.	317	-61	2.0
			100	322	-65	1.5
			200	322	-65	0.8
			300	333	-77	0.8
			500	334	-56	0.2

Site	Sample	Specimen	Treatment	D	I	Mx10^{-6} (emu/cc)
5	b	51	NRM	291	-62	2.1
			50 oerst.	305	-63	1.8
			100	311	-57	1.3
			200	311	-72	0.8
			300	344	-86	0.4
			400	302	-57	0.4
5	c	31	NRM	341	-62	3.3
			50 oerst.	349	-63	2.9
			100	354	-64	2.4
			200	357	-67	1.6
			300	006	-71	1.1
			400	351	-70	0.7
			500	096	-81	0.5
5	c	32	NRM	348	-66	3.6
			50 oerst.	353	-63	3.1
			100	357	-53	2.6
			200	357	-65	1.7
			300	354	-53	1.0
			400	002	-79	0.6
5	c	61	NRM	346	-66	2.7
			50 oerst.	347	-65	2.4
			100	351	-65	2.1
			200	350	-68	1.5
			300	354	-66	0.9
			400	000	-82	0.9
5	c	62	NRM	354	-67	3.4
			100^{o}C	003	-59	2.8
			190^{o}C	001	-59	2.2
			300^{o}C	003	-64	1.7
			410^{o}C	005	-74	1.3
			500^{o}C	021	-82	0.8
			590^{o}C	185	-20	1.5

Site	Sample	Specimen	Treatment	D	I	Mx10^{-6} (emu/cc)
6	a	11	NRM	180	-78	4.1
			50 oerst.	144	-83	3.8
			100	130	-85	3.1
			200	063	-88	2.1
			300	345	-78	1.5
			400	278	-85	1.3
			500	259	-55	0.2
6	a	31	NRM	159	-76	3.8
			50 oerst.	126	-81	3.5
			100	109	-82	2.9
			200	030	-87	1.9
			300	352	-82	1.1
			400	349	-80	0.8
6	a	41	NRM	171	-73	3.7
			50 oerst.	142	-79	3.2
			100	149	-82	2.6
			200	089	-86	1.7
			300	071	-85	1.0
			400	351	-57	0.3
6	b	11	NRM	263	-75	2.3
			50 oerst.	319	-84	2.1
			100	337	-79	1.8
			200	344	-72	1.2
			300	335	-65	0.7
			400	342	+21	0.4
			500	347	-63	0.7
6	b	21	NRM	285	-72	2.6
			50 oerst.	320	-81	2.4
			100	346	-79	2.0
			200	354	-67	1.3
			300	348	-52	0.7
			400	350	-44	0.6

Site	Sample	Specimen	Treatment	D	I	$Mx10^{-6}$ (emu/cc)
6	b	32	NRM	287	-69	2.4
			50 oerst.	329	-77	2.1
			100	343	-77	1.8
			200	349	-73	1.3
			300	344	-66	0.8
			400	353	-33	0.7
6	b	31	NRM	278	-77	2.7
			100°C	285	-71	2.1
			190°C	287	-71	1.8
			300°C	308	-65	1.1
			410°C	309	-45	0.7
			500°C	318	-62	0.6
			590°C	019	-58	0.3
6	c	11	NRM	351	-59	3.6
			50 oerst.	015	-53	3.5
			100	019	-52	3.1
			200	019	-52	2.3
			300	024	-48	1.4
			400	025	-35	0.8
			500	042	-54	0.8
6	c	31	NRM	349	-72	4.9
			50 oerst.	019	-60	4.4
			100	011	-57	3.8
			200	018	-55	3.0
			300	015	-51	1.7
			350	014	-50	1.5
			400	026	-42	1.2
			500	041	-60	0.9
			600	352	+13	0.3
6	c	51	NRM	006	-67	3.9
			50 oerst.	015	-58	3.7
			100	017	-55	3.4
			200	017	-55	2.5

Site	Sample	Specimen	Treatment	D	I	Mx10^{-6} (emu/cc)
			300	024	-52	1.7
			400	325	-52	0.7
			500	044	-19	1.1
7	a	11	NRM	258	-52	43.4
			100°C	258	-49	28.4
			190°C	257	-51	19.3
			300°C	256	-52	11.5
			410°C	267	-67	6.1
			500°C	292	-82	2.9
			590°C	096	-13	1.3
7	a	12	NRM	294	-67	25.7
			100°C	298	-71	20.4
			190°C	309	-73	14.7
			300°C	333	-77	10.1
			410°C	011	-58	6.5
			500°C	031	-50	4.7
			590°C	037	-46	3.7
7	a	21	NRM	269	-55	35.6
			100°C	266	-54	23.0
			190°C	265	-54	15.8
			300°C	265	-54	9.2
			410°C	291	-61	4.9
			500°C	275	-71	1.8
			590°C	346	+15	1.7
7	b	12	NRM	052	-81	7.0
			100°C	044	-80	5.8
			190°C	040	-83	3.8
			300°C	000	-84	2.2
			410°C	291	-85	0.9
			500°C	274	-72	0.4
			590°C	097	-7	0.6

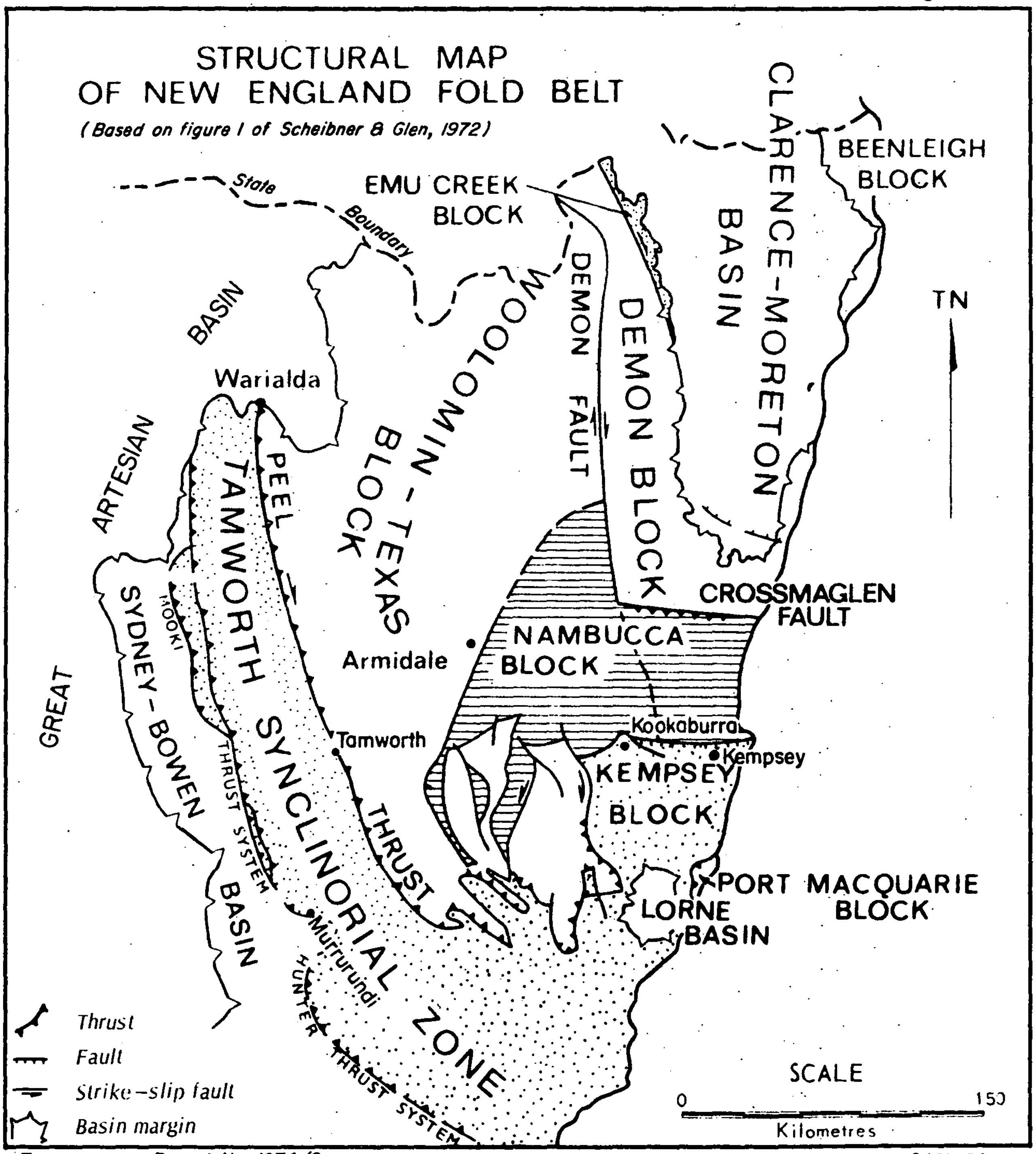
Site	Sample	Specimen	Treatment	D	I	Mx10^{-6} (emu/cc)
7	b	31	NRM	023	-77	6.3
			100°C	029	-76	5.3
			190°C	023	-80	3.6
			300°C	016	-81	2.0
			410°C	212	-86	1.0
			500°C	183	-74	0.6
			590°C	154	-64	0.8
7	c	11	NRM	007	-72	13.8
			100°C	000	-70	10.6
			190°C	005	-70	8.0
			300°C	004	-71	5.3
			410°C	023	-71	3.6
			500°C	041	-70	2.5
			590°C	097	-69	1.7
7	c	12	NRM	341	-73	15.4
			100°C	350	-71	11.2
			190°C	347	-72	8.1
			310°C	002	-72	5.0
			410°C	011	-75	3.3
			500°C	005	-74	2.4
			590°C	291	-74	2.7
7	c	21	NRM	351	-71	12.7
			100°C	347	-71	9.3
			190°C	339	-70	6.8
			300°C	335	-73	4.2
			410°C	354	-72	2.7
			500°C	033	-69	2.2
			590°C	042	-59	1.8
7	d	12	NRM	336	-73	12.3
			100°C	340	-73	9.1
			190°C	327	-74	6.5
			300°C	319	-78	4.0

Site	Sample	Specimen	Treatment	D	I	Mx10^{-6} (emu/cc)
			410°C	201	-20	4.3
			500°C	271	-70	1.5
			590°C	212	-14	0.8
7	d	21	NRM	343	-69	12.2
			100°C	346	-73	8.7
			190°C	335	-74	6.5
			300°C	327	-75	4.0
			410°C	312	-77	2.2
			500°C	256	-69	1.2
			590°C	326	+11	0.7
7	d	31	NRM	320	-67	11.6
			100°C	332	-69	8.6
			190°C	318	-69	6.0
			300°C	294	-68	3.3
			410°C	251	+8	4.5
			500°C	293	-69	1.2
			590°C	295	-8	1.3
8	a	11	NRM	045	-56	16.8
			100°C	053	-46	15.4
			190°C	061	-41	14.4
			300°C	066	-22	10.0
			410°C	070	-10	8.9
			500°C	071	-8	8.0
			590°C	075	+1	6.2
8	a	12	NRM	054	-56	16.0
			105°C	062	-47	14.9
			190°C	067	-39	12.5
			300°C	075	-23	10.0
			410°C	079	-2	8.6
			410°C	079	-1	8.8
			500°C	079	+1	7.8
			590°C	083	+8	7.0

Site	Sample	Specimen	Treatment	D	I	$Mx10^{-6}$ (emu/cc)
8	a	13	NRM	059	-62	14.3
			100°C	068	-52	12.9
			190°C	072	-44	10.6
			300°C	081	-24	8.2
			410°C	083	-9	7.2
			500°C	085	-6	6.6
			590°C	088	+2	45.5
8	b	11	NRM	015	-70	41.3
			100°C	019	-64	32.7
			190°C	028	-60	21.2
			300°C	052	-39	9.4
			410°C	069	-9	6.9
			500°C	076	-3	7.4
			590°C	076	+1	7.4
8	b	12	NRM	008	-65	38.4
			100°C	018	-65	28.5
			190°C	023	-61	19.1
			300°C	050	-46	8.6
			410°C	067	-13	5.7
			500°C	069	-5	6.1
			590°C	073	-6	6.9
8	b	13	NRM	000	-66	32.5
			100°C	013	-62	24.5
			190°C	028	-64	16.8
			300°C	043	-46	7.7
			410°C	062	-11	5.1
			500°C	072	-5	5.7
			590°C	071	+18	5.2
8	c	11	NRM	030	-65	23.5
			100°C	043	-63	18.1
			190°C	049	-61	14.6
			300°C	061	-54	9.3

Site	Sample	Specimen	Treatment	D	I	Mx10^{-6} (emu/cc)
			410°C	068	-47	7.2
			500°C	071	-42	5.9
			590°C	073	-41	4.3
8	c	12	NRM	062	-49	24.2
			100°C	067	-43	21.1
			190°C	070	-38	18.4
			300°C	076	-27	13.4
			410°C	077	-21	11.2
			500°C	076	-19	10.1
			590°C	077	-11	7.5
8	c	13	NRM	057	-45	20.3
			100°C	065	-41	18.6
			190°C	069	-37	16.7
			300°C	074	-29	12.6
			410°C	076	-22	11.1
			500°C	077	-21	9.6
			590°C	078	-18	8.0

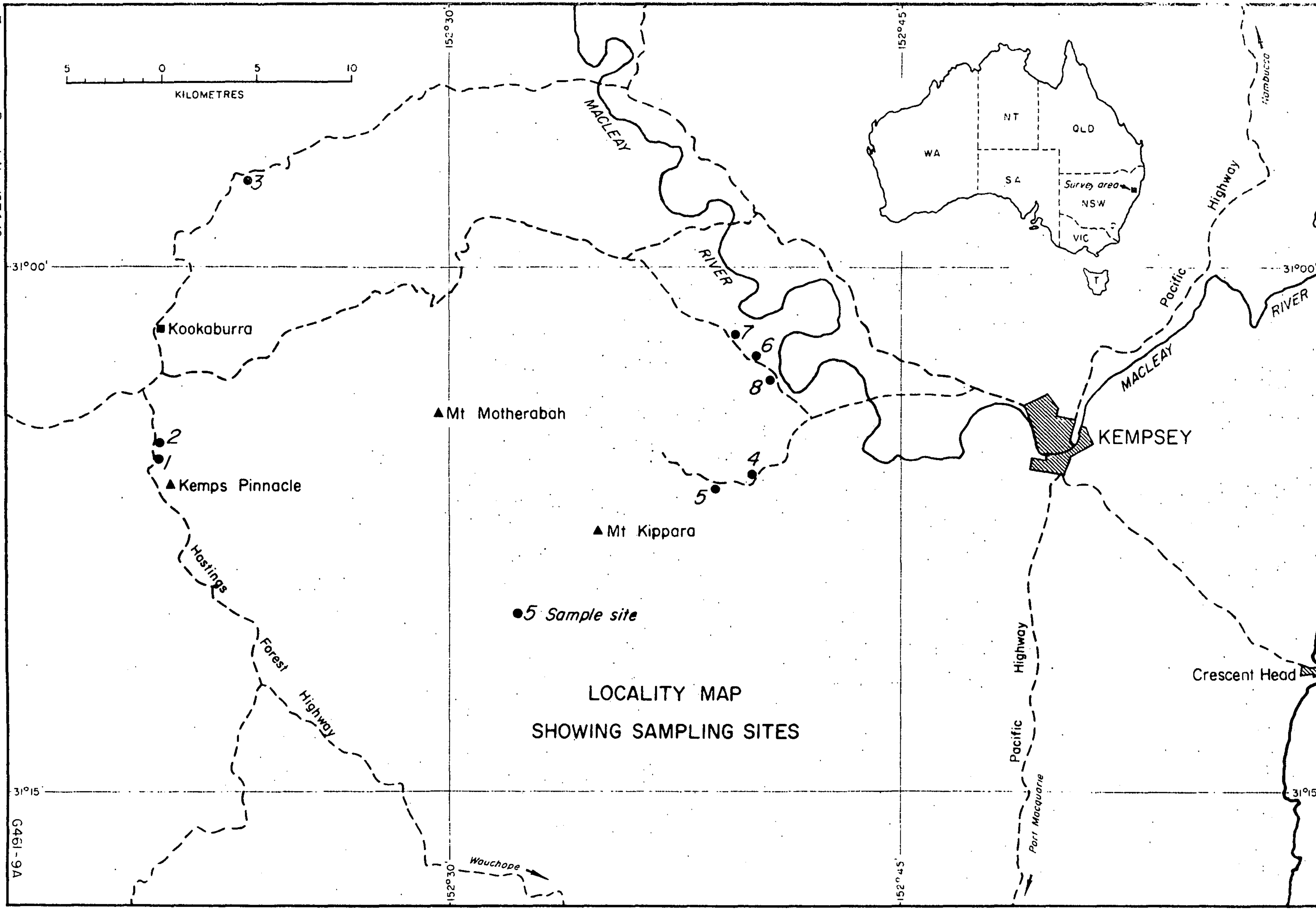
Fig. 1



To accompany Record No. 1974/6

G461-8A

To accompany Record No 1974/6



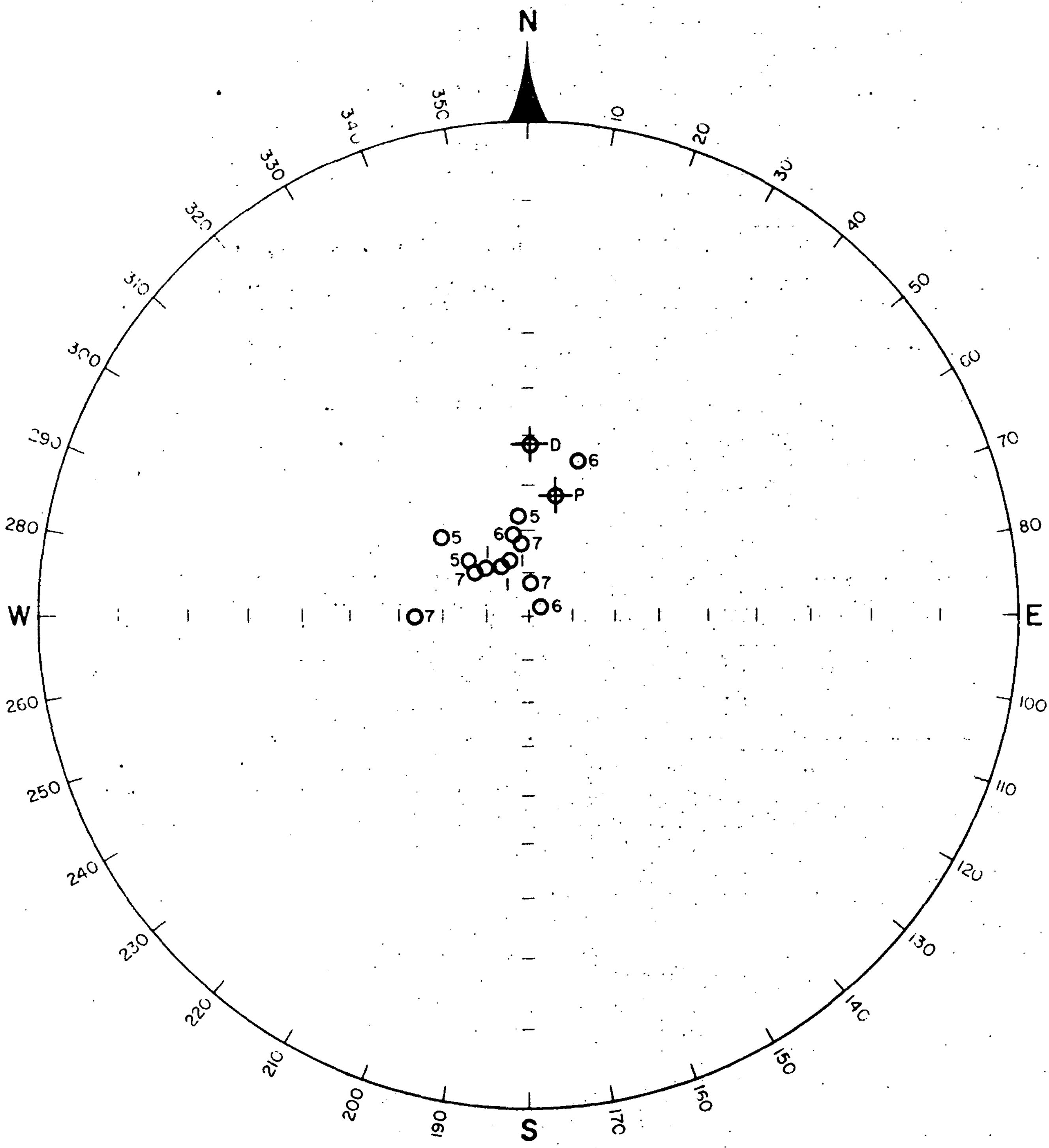
LOCALITY MAP

SHOWING SAMPLING SITES

G461-9A

Fig. 2

Fig. 3A



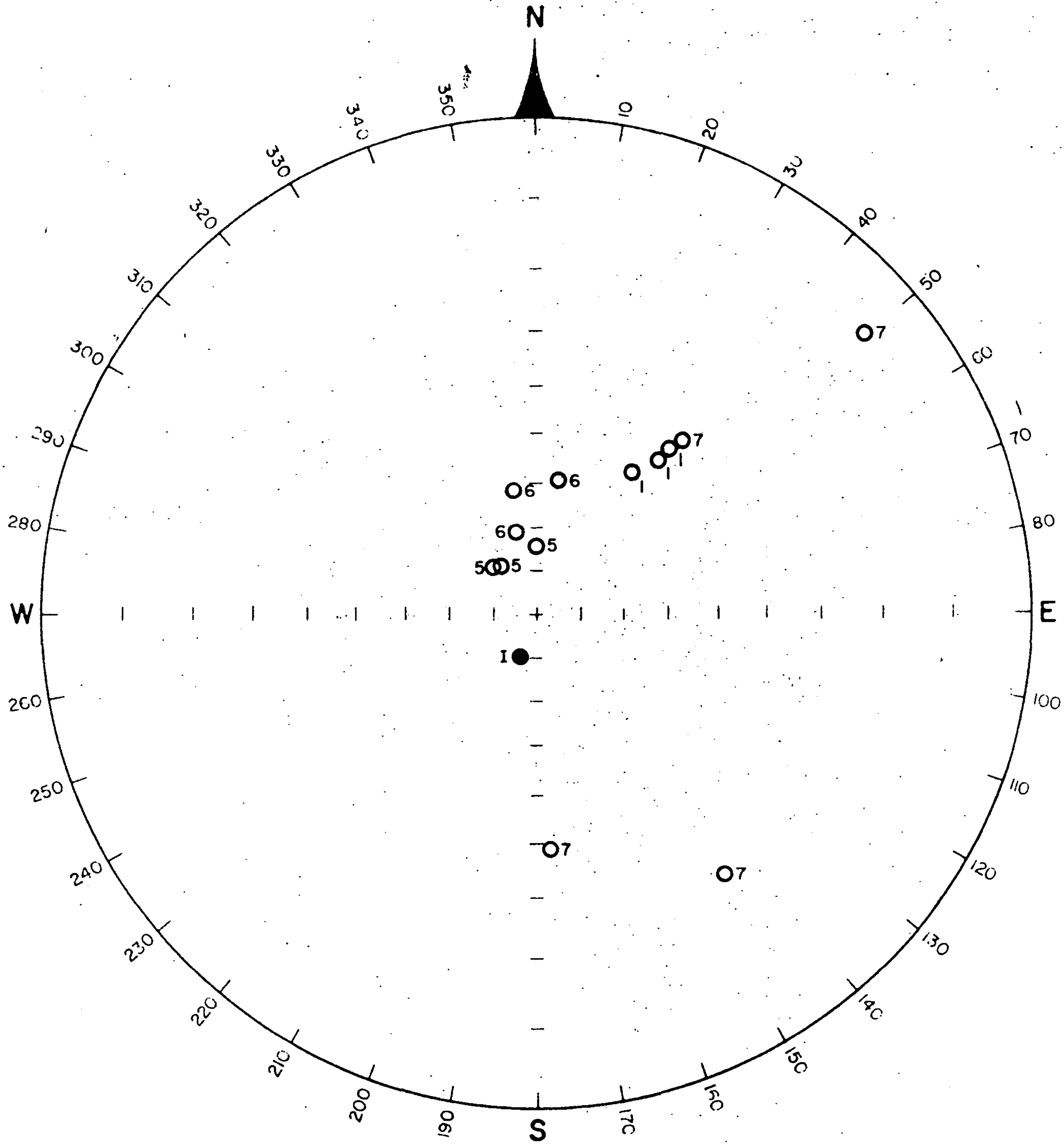
D, P are the axial dipole and present field directions at the Hunter Valley locality - 151°E, 32°S (Irving, 1966)

STEREOGRAPHIC PLOT OF REMANENCE DIRECTIONS

PRESENT-DIRECTION DIAGRAM

G461-10A

Fig. 3B



I is direction for the Upper Carboniferous Hunter Valley sites. (Irving, 1966)
Note positive polarity

STEREOGRAPHIC PLOT OF REMANENCE DIRECTIONS
PALAEODIRECTION DIAGRAM

G461-11A