PRJ, Vol. 2 (January 1990); P. 71–77, 3 FIGS, 1 TABLE.

Short Note

A PRELIMINARY PHOTOGEOLOGIC INVESTIGATION AND STRUCTURES OF THE BASEMENT ROCKS, SOUTHERN PART OF JABAL EIGHEE AREA, LIBYA

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إستخدام الصور الجوية في دراسة أولية لجيولوجية الصخور القاعية المتكشفة بالمنطقة الجنوبية لجبل إيقي — ليبيا

محمود بن عيسى

تمت دراسة الجيولوجيا التركيبية للصخور القاعية المتكشفة لمنطقة جبل ايقي ، بشمال شرق تيبستي وذلك باستخدام الصور الجوية بمقياس رسم 1:60.000 ، ومن خلال تفسير هذه الصور الجوية وصور القمر الصناعي الفرنسي (سبوت) تم التعرف على تسع وحدات صخرية بمنطقة الدراسة . . قسمت هذه الوحدات الصخرية المتكشفة إلى : صخور متحولة من أصل رسوبي صخور الشيست ، دخلات الصهير البركاني ، الصخور الجرانيتية ، الحجر الرملي الكمبرو — أوردوفيشي ، ترسبات السيلوري البحرية ، الحجر الرملي الديفوني ، البيروكلاستيك البركانية والرسوبيات الحديثة . . ووجد بأن منطقة الدراسة كانت قد تعرضت إلى حركات رجية ذات إتجاهات مختلفة تشابه نظام التصدع المتعارف عليه بمنطقة حوض سرت .

INTRODUCTION

In this investigation, a mirror stereoscope with magnifying binoculars and a stereo zoom transfer scope with variable magnification ranging from 2.3X to 16.1X were used. This instrument is adapted for viewing of prints or transparencies of two sizes (13 by 13 cm or 23 by 23 cm).

During the investigation 130 black and white aerial photographs (scale 1:60,000) taken in 1962 were analysed. SPOT images were used as a base map with a scale of 1:400,000 to correlate the results obtained from the aerial photographs and to add more information about the structure of the area.

Preliminary photo-interpretation and construction of a mosaic of the study area resulted in a photogeologic map, (Figs 1 and 2).

The aim of this study is to serve as a first step towards documenting the tectonic/structural evolution of Libya by mapping and analysing the structural features of the exposed basement in southern Libya.

The area under study represents the southern part of Jabal Eighee. It lies between Al Kufrah basin in the east and Sarir Tibisti to the west on the extreme northern end of the Tibisti massif (Fig. 1).

STRUCTURE OF THE AREA

The structures presented herein are tentative as they are based on photo-interpretation and compilation of identified structures on rose diagram plots (Fig. 3) without substantiation of field checking.

Two major linear systems (NW–SE and NE–SW) are evident from the data presented in the photogeological map and the generalized geological interpretation map (Fig. 1 and 2).

The NW–SE and NE–SW fault systems represent the major trends of possible faults and true faults. These fault systems are thought to have been active at various times with faults being abadoned, rejuvenated or extended. These identified structural trends are also present and equally salient in the basement rocks on a very broad regional scale; occuring in the Tibisti area (Conant and Goudarzi, 1977).

The majority of the linears are the surface reflection of zones of weakness (fractures) associated with the basement, and are recognizable in the overlying rock cover. Although they may represent a one time movement within the Precambrian, many of the fractures seem to have been rejuvenated later during geologic time as reflected in the overlying sediments of Palaeo-

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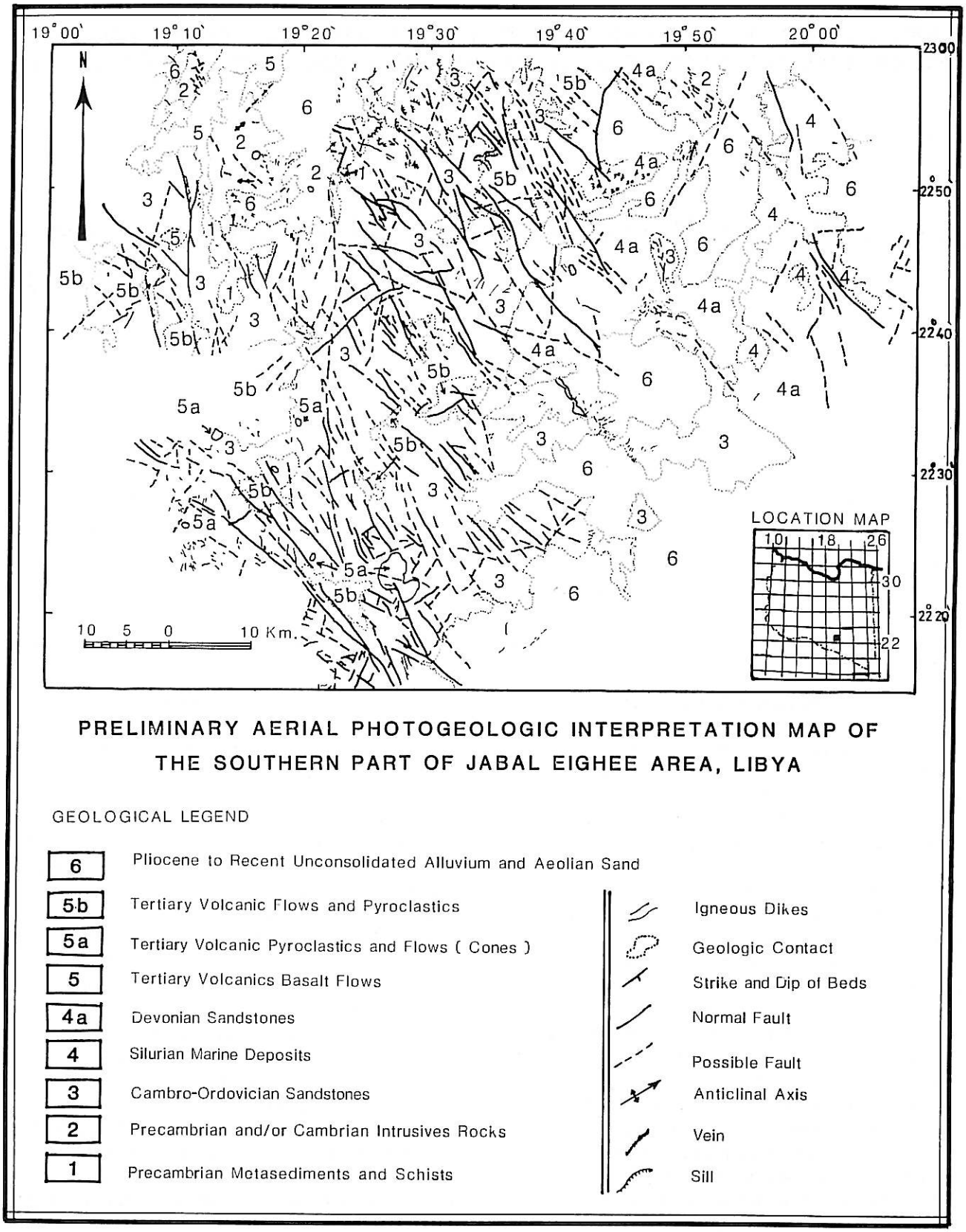

FIG. 1 Photogeologic map of the area of study.

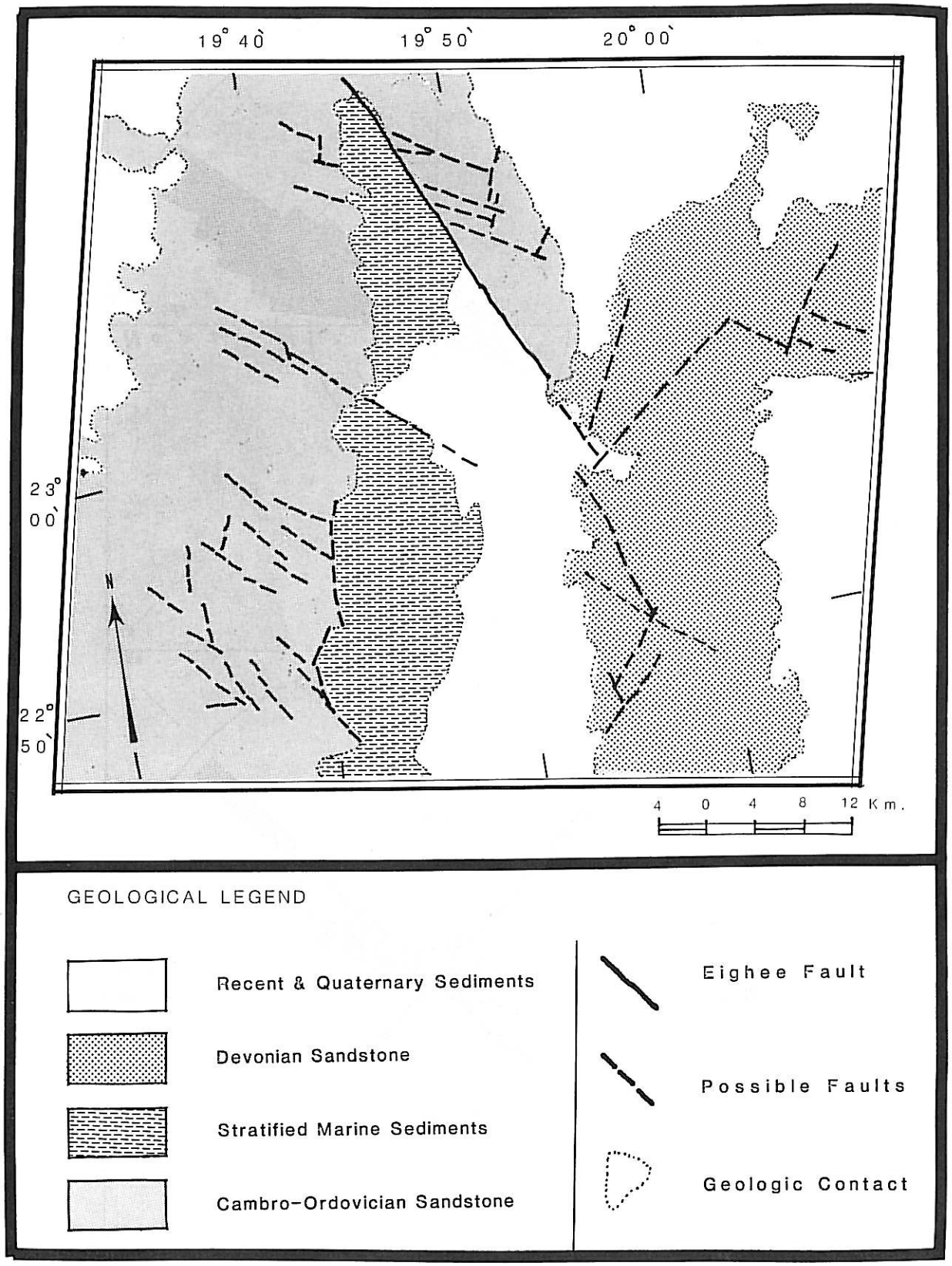

FIG. 2. Generalized Geological interpretation map based on SPOT Images.

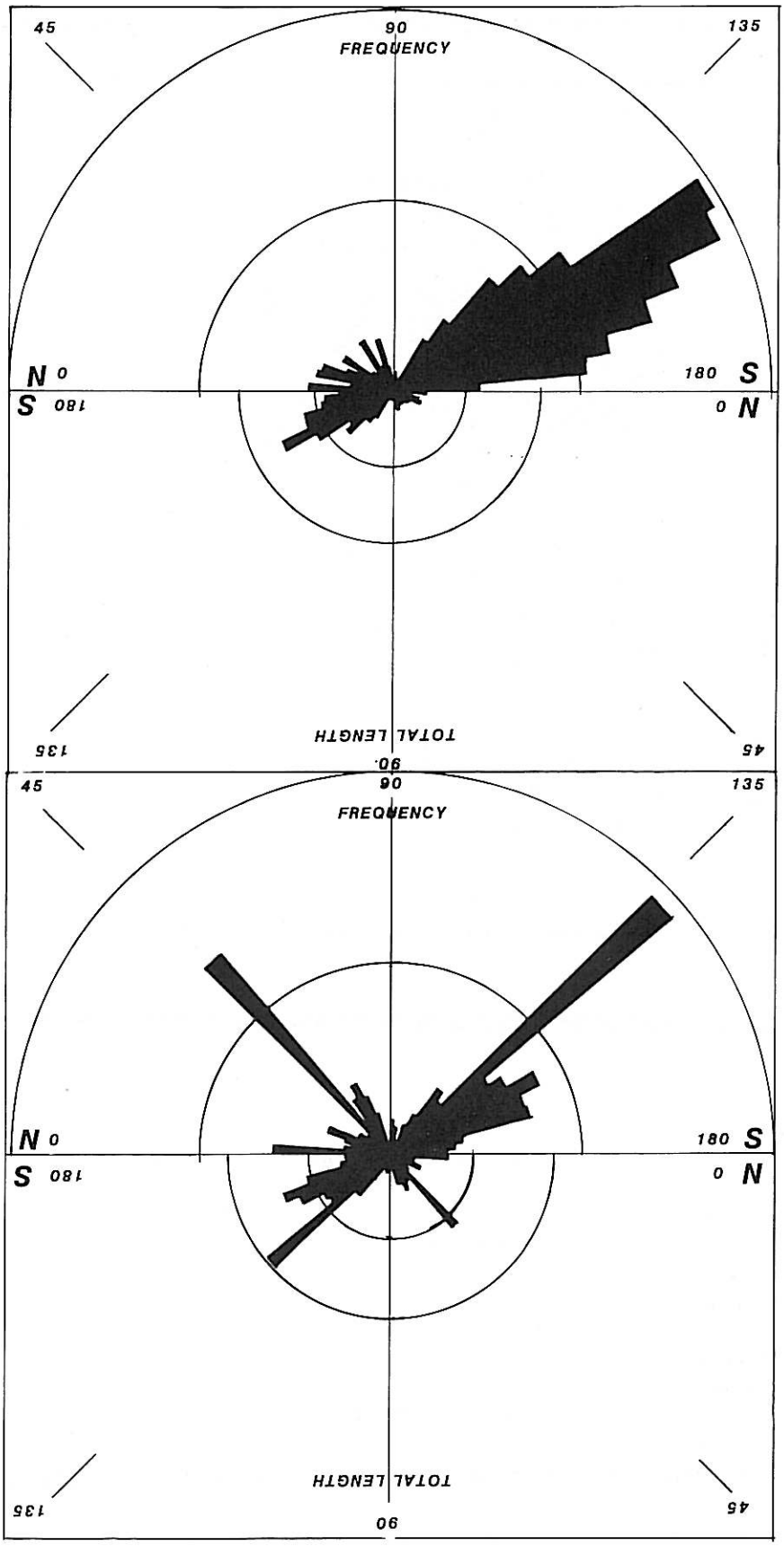

FIG. 3. Rose diagram (frequency and total length) of mapped faults and dikes, southern part of Jabal Eighee area, Libya.

zoic age. Some linears, however, may represent fractures of the sedimentary rocks caused by differential compaction on ancient topographic ridges.

This investigation indicates that long linears are most common in the Cambro-Ordovician sandstone and the surrounding areas. It was found that the orientations of dikes, faults, and possible faults exhibit great variations. These variations may be explained by differences in strike of local and regional structures (Table 1). The major tectonic activities include the Caledonian and Hercynian orogenies and disturbances during Cretaceous, Middle Tertiary (Oligocene-Miocene) and Holocene time (Klitzsch, 1966, 1971). These events caused uplifts, subsidences, tilting, faulting and intrusions. However, the effects of these tectonic events were generally broad.

Caledonian Trends and Movements

The main Caledonian phase was dated as Middle Silurian and Devonian. This has been suggested in several localities; south of the Ghadamis basin, Murzuq basin and also in Al-Kufrah basin. The fault trends associated with the Caledonian orogeny are toward NW–SE direction (Bellini and Massa, 1980).

TABLE 1 STRIKE OF THE LINEARS

Frequency (ϕ) From North to South (0°-180°)

LINEARS	FAULTS	DIKES	POSSIBLE FAULTS	TOTAL
00-04	9	43	18	70
05-09	3	17	11	31
10-14	4	14	5	23
15-19	7	17	2	26
20-24	8	24	8	40
25-29	5	12	9	26
30-34	5	13	6	24
35-39	4	8	7	19
40-44	1	9	13	23
45-49	4	06	14	114
50-54	1	12	10	23
55-59	4	24	8	36
60-64	0	29	7	36
65-69	4	23	5	32
70-74	5	16	3	24
75-79	2	7	1	10
80-84	0	7	5	12
85-89	1	9	2	12
90-94	2	13	0	15
95-99	1	2	3	6
100-104	1	10	1	12
105-109	1	6	1	8
110-114	1	6	2	9
115-119	2	12	4	18
120-124	8	17	5	30
125-129	10	30	10	50
130-134	10	26	7	43
135-139	16	134	24	174
140-144	14	44	18	76
145-149	23	49	26	98
150-154	32	60	36	128
155-159	24	52	25	101
160-164	24	53	25	101
165-169	19	27	23	69
170-174	18	24	22	64
175-179	9	21	10	40

Data in Libya supporting Caledonian movement have been described for the east Murzuq basin (western Sirt basin) by Klitzsch, (1963). He mapped NW trending faults in Cambrian strata, which do not cut younger strata, and an angular unconformity of up to 40 degrees between Cambrian and Ordovician rocks all of which could point to early Caledonian movements.

Hercynian Trends and Movements

This corresponds to the second major tectonic phase which has affected the Palaeozoic rocks. Its initial phases were dated as Middle to Late Carboniferous and were thought to be persisting throughout the Permian time, (Bellini and Massa, 1980). The Hercynian Orogeny has caused foldings, faulting and strong subsidences in many parts of Libya, generally oriented in NE–SW direction.

These North-West and North-East-trending faults intersect near the central part of the country, the site of the largest outpourings of lava in Jabal al Haruj, Libya (Goudarzi, 1980).

The individual linears vary in length, and the major linear features in the study area are parallel to Eighee fault as well as the main fault trends of the Sirt basin units (Fig. 1).

LITHOLOGIC INTERPRETATION

Nine rock units have been identified and mapped. Each of these units have been identified using standard aerial photograph interpretation techniques, i.e., analysis of textural, tonal, geomorphological and erosional characteristics.

Their classification by age is based upon the rock units, spatial relationships, and the geological map of Libya (Conant and Goudarzi; 1977). Wherever possible, the contacts of the units beneath the overburden have been mapped by identifiable slight topographic and tonal variations as well as isolated exposures of the units (Fig. 1).

The Precambrian Meta-sediments and Schists (Unit 1)

This unit appears as a series of narrow ridges having associated tonal-banding of grey tone on the exposed tops of ridges while the topographic lows are of lighter tone depending upon the degree of exposure. This unit is probably equivalent to the Upper Tibistian Metasediments described by Schurmann (1974).

The Precambrian and/or Cambrian Intrusives (Unit 2)

When exposed, this unit appears on the aerial photographs with a dark grey tone and a very coarse texture. Jointing in this unit is very well developed with

the major trend in a NW direction throughout the entire study area.

Cambro-Ordovician Sandstones (Unit 3)

This unit appears on the aerial photographs as beds of rocks with a medium to moderately dark grey tone and an extremely coarse texture due to the very dense, well developed multiple jointing. The major distinguishing features of this unit is the strong drainage controlled by the joints as compared to the lack of joint drainage control in the area of intrusive bodies.

Silurian Marine Deposits (Unit 4)

This unit is not well exposed as it is mainly covered by alluvium and aeolian sand. When exposed, the bedding is apparent at about 30 degrees, toward the NE. The major trend of faults in this unit is NW (Fig. 2).

Devonian Sandstones (Unit 4a)

The distinguishing features of this unit is the presence of a dendritic drainage pattern and a darker tone compared to the Cambro-Ordovician. This unit is less resistant than the Cambro-Ordovician sandstone observed in this investigation.

Tertiary Volcanic Basalt Flows (Unit 5)

The constructional surfaces of lava flows, make conspicuous topographic features readily observed on aerial photographs. The surface of such flows can be identified by the presence of general lobate form extending from the extrusive source, which may often consist of fissures, volcanic cones and to a lesser extent volcanic vents. Lava flowing down a wadi has an elongate form and during its filling of the wadi, it changed the paleodrainage system.

Tertiary Pyroclastic Cones and Flows (Unit 5a)

A variety of different pyroclastic cones and flows are present within the study area. The youngest of these are small.

These cones are not older than Tertiary and not younger than Pleistocene age. There are also low sloping vents of medium to dark tone within the Tertiary basaltic flows (unit 5).

Tertiary Volcanic Flows and Pyroclastics (Unit 5b)

The pyroclastics appear as a very dark toned rock, and usually, is capping the Cambro-Ordovician sandstone. In many areas the drainage within this unit is controlled by the underlying rock unit.

Pliocene to Recent Unconsolidated Alluvium and Aeolian Sand (Unit 6)

This unit is abundant in the topographically low areas where aeolian sand, which occurs as extensive sand sheets of varying thickness, overlies older alluvial sand. In this preliminary investigation, a large alluvium fan is thought to have been deposited from high area (Cambro-Ordovician) to cover the bedding of Silurian marine deposits (Fig. 2).

Dikes

Extensive dike swarms have been observed throughout the area. The trends and abundance of these dikes are thought here to be indicative of local tectonic events prior to and during emplacement (Fig. 1).

CONCLUSIONS

The deposition and/or erosion of Phanerozoic sediments appear to have been largely controlled by epeirogenic fluctuations along earlier, mostly Precambrian structures resulting in Cambro-Ordovician sandstone and younger exposed rocks. The major linear features in the study area are parallel to the Eighee fault as well as to the main fault trends of the Sirt basin. These identified structural trends are also present and equally salient on a very broad regional scale, in the basement rocks in the Tibisti area (Conant and Goudarzi, 1977).

The chronostratigraphic arrangement of the rock units is based on the observed spatial relation of the rock units (from oldest to youngest), the Precambrian meta-sediments are interpreted as being the oldest rock units within the study area.

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REFERENCES

Bellini, E. and Massa, D., 1980, A stratigraphic contribution to the Palaeozoic of the southern basins of Libya. In: *The Geology of Libya* (eds: M.J. Salem and M.T. Busrewil) London, Academic Press, Vol. 1, 3–57.

Conant, L.C. and Goudarz, G.H., 1977, *Geologic map of Libya*, 1:2,000,000. 2nd edition, Ind. Res. Cent. (Tripoli).

Goudarzi, G.H., 1980, Structure Libya. In: *The Geology of Libya* (eds: M.J. Salem and M.T. Busrewil). Academic press, London, 879–892.

Klitzsch, E., 1963, Geology of the north-east flank of the Mursuk basin. In: *First Saharah Symposium*, (ed.:) Petroleum Exploration Society of Libya, 97–113.

Klitzsch, E., 1966, Geology of the north-east flank of the Marzuk basin. In: *south-central Libya and northern Chad* (ed.: J.J. Williams) Petrol Explor. Soc. Libya, 8th annu. Field Conf. 19–32.

Klitzsch, E., 1971, A structural developments of parts of North Africa since Cambrian time. In: *Symposium on the Geology of Libya* (ed.: C. Gray), Fac. Sci., Univ. Libya, Tripoli, 253–262.

Schurmann, H.M.E., 1974, The Precambrian in North Africa, E.J. Brill, Leiden, LTD 404 p.

Vail, J.R., 1968, The southern extention of the East Africa Rift System. geol. Rdsch., 57, 601–614.

Vail, J.R., 1970, Dike swarms and volcanic activity in North-Eastern Africa. In: *Symposium on the Geology of Libya*, (ed.: C. Gray) Fac. Sci. Univ., Tripoli, Libya, 341–343.