IMPERIAL COLLEGE

OF SCIENCE & TECHNOLOGY

ETHIOPIA

1967

THE EXPLORATION BOARD.

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IMPERIAL COLLEGE

ETHIOPIA EXPEDITION 1967

A B S T R A C T

The Imperial College Ethiopia of 1967 had two main objectives:

(a) A study of the Airways system.

(b) The mapping of the Geology of an area on the edge of the Rift Valley.

This Report consists, primarily, of the summaries of the results of these two studies.

I N T R O D U C T I O N

The Report is designed to fall someway between the usual Provisional and Final reports produced by Imperial College Expeditions. It was thought necessary as the former provides very little information and the latter is becoming prohibitively expensive to produce. Anyone who wishes to have move detailed information on either the Geological Mapping or the Aviation Survey should contact either John Harris or Christopher Satchwell respectively.

It will be found that this Report is divided into three sections, each of which is self-contained and should be left to speak for themselves. Between them they give a fairly complete picture of the whole Expedition. Two sections deal specifically with the studies carried out during our stay in Ethiopia, whilst the third consists of the personnal comments and impressions of one of the members of the Geological Mapping Group.

E X P E D I T I O N M E M B E R S

All the usual personnel problems were encountered so it is, perhaps, best just to say that the following were present on the Expedition:

C Satchwell

C. French

J. Harris

T. Marples

C. St.John

The Expedition divided, by virtue of the two studies carried out, into two groups. C. Satchwell and C. French, with the particular assistance of Levin Djerahan, covered the Aviation Survey whilst the remaining three worked on the Mapping Project.

The personnel are conventionally introduced individually.

C.J. Satchwell

Chris was responsible for the original planning on the Expedition and took upon himself the task of leadership and much of the work connected with any such activity. At the time of planning he was a third year Aeronautical Engineer. He has since graduated and is now working for Hawker Siddley Aviation.

C. French

Chris, also a third year Aeronautical Engineer, was the latest member to join the group. He has also now graduated but has chosen to remain at Imperial College as a Post Graduate in Operations Research and Management Studies.

It was Chris who finally enabled the expediton to leave England, as he managed to sort out our travel arrangements after the upheaval caused by the closure of the Suez Canal.

J. Harris

John, our tireless geologist, to whom any credit for the Geological Project must go. He is now in his third year, studying geology, and the report of the geological group will be put forward as his final year project.

T. Marples

Tom, the other second year undergraduate, is currently in third year Metallurgy. He was to be the'Expedition Land Rover Expert' but deprived of his Land Rover he joined the Geological Group and has recorded his impressions as a displaced person.

C. St.John

Recruited,during the glamerous days of planning, for surveying and climbing Chris, like Tom, turned his hand to Geology. A third year Mining Engineer at the time, he has since graduated but remains at Imperial College as a Post Graduate doing research into Rock Mechanics.

A C C O U N T S

Simplified Balance

E X P E N D I T U R E

	£.	s.	d.	£.	s.	d.
TRAVEL COSTS	1,303	19	0			
TENT	50	0	0			
MEDICAL SUPPLIES	25	0	0			
OTHER EXPENDITURE	502	5	5			
	1,886	15	11			
LOSS ON LAND MOVE	62	0	0			
TOTAL EXPENDITURE				1,948	15	11

I N C O M E

	£.	s.	d.	£.	s.	d.
DONATIONS	1,035	13.	0.			
PRIVATE [illegible]	70	0	0			
SUNDRY RECEIPTS	64	19	10			
GRANT TO J. HARRIS	30	0	0			
PERSONAL CONTRIBUTIONS	310	0	0			
TOTAL GRANT FROM I.C. EXPLORATION BOARD	438	3	1			
TOTAL TOTAL INCOME				1,948	15	11

We are indebted to the following for their generous support:

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PART I

AIR TRAFFIC IN ETHIOPIA

- by -

C.J. SATCHELL BSc. A.C.G.I.

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INTRODUCTION

The information presented in this report was obtained during the summer of 1967 by the Imperial College Ethiopia Expedition. Ethiopian Airlines, Civil Aviation Administration and the Imperial Highways Authority all assisted in providing information.

Details of Runways from a performance engineers viewpoint, are given, as well as details of passenger and freight loads. Annual growths are estimated with varying degrees of accuracy. The usual arguments about Urbanisation, increase in Gross National Product and Population Increase do not apply to many routes for a variety of reasons. Also accurate Census information does not exist, nor does accurate information on "Urbanisation", on account of the many small businesses which are continually springing into existence. A method of estimating Annual growth has been divised for Ethiopia. It utilises the growth in Government investment, growth in Tourist industry and changes in road networks as well as many other factors. The main virtue of this method is that it is adaptable to the special problems of the Ethiopian Economy. Many of the higher growth rate estimates are inaccurate, because of the problems of anticipating the tourist influx in the coming years. The accuracy of estimated growth rates on many other routes, has been impaired because of poor census information.

Very few people travel from one region to another. The Airline operate their services on a purely regional basis, and the report is therefore divided into Chapters, each dealing with one region. Patterns of traffic movement are noticeable, and the routes studied in this report, have been selected to illustrate the bulk of air-traffic movement throughout the Empire. Complete information on all passenger and freight movement in the Empire for the year of 1966 is available in the Appendix. The yearly totals for 1965 are also given.

Figure 1 is a map of the routes of Ethiopian Airlines.

1. Southern Region

1.1. Airfields :- Addis Ababa, Goba, Dodolla, Ghinner, Masslo.

1.2. Services

Outward				Homeward		
C.47	C.47	C.47	Aircraft	C.47	C.47	C.47
Mon.	Th.	Sat.	Weekdays	Mon.	Th.	Sat.
			Cities			
*	*	*	Addis Ababa	*	*	*
*	*		Goba	*	*	
		*	Adaba			*
	*		Dodolla			
*			Ghinner		*	
	*	*	Goba		*	*
*		*	Masslo	*		*

1.3. General

Southern Region services thrive because of poor surface communications and the natural wealth of the countryside. When new roads are completed from Adaba to Goba and from Goba to Ghinner, much of the present traffic will vanish, but it is more than likely that new airstrips, located near isolated towns will continue to support an airline service. The present internal

security operations in the area have two effects on the airline. The first is to provide more traffic, both passenger and freight, as government officials and rifles are flown to Army garrisons. The second, is to inhibit economic development of the area and loose the traffic which would have been generated by this development. When the military do withdraw, the airline should profit until the withdrawal has been completed, when a slack period should set in, until the region develops.

The only all-weather road in the region connects Shashemene with Adaba, thereafter a seasonal road exists as far as Goba, and a trail, which frequently vanishes into scrub, goes on to Ghinner All other roads marked on maps are either fiction, or else open scrub which some vehicles can drive over. Beyond Adaba, the only vehicles seen are either 4 wheel drive trucks or landrovers. A new road is being constructed, which will connect Adaba Goba and Ghinner.

Bus services in the region operate only between Goba, Adaba and Addis Ababa. Services to Goba are restricted to the dry season, and are always unpleasant, as the bus takes a day to cover the 92 km. between Goba and Adaba. It takes a further day to reach Addis Ababa and the cost of the total journey is 145th.$ or 32 sterling.

Airline operations in the region, normally work by doing a shuttle service from Goba to the outlying towns of Ghinner, Masslo and Dodolla.

1.4.1. Route

Addis Ababa - Adaba - Goba

Most of the traffic on this route goes to Goba. Some passengers who cannot afford the direct airfare take the bus on the All-weather road as far as Adaba and then fly the 32 km. to Goba. This is done more in the rainy season than the dry, and as many as 110 passengers travel from Adaba to Goba in the wettest month. Normal traffic between Adaba and Goba is about 60 passengers/month.

Traffic between Addis and Goba is around 90 passengers and 4,500 kilos of freight/month. During the three rainy months of July, August and September 155 passengers/month are normally carried. In July and September, freight figures are normally 8,500 kilos/month, rising to 12,000 kilos/month in August. On the return journey, passenger figures are the same, but freight figures are down to only one fifth of the south bound.

When the new road from Adaba is completed, much of this traffic will be lost, although Goba's position as provincial capital of Bale Province, market town for the surrounding district, and headquarters of the fight against the shift has assured a reasonable future for its Airline services. If Hotels were

built in the town, the area would have a large tourist appeal, and much of the lost traffic could be recaptured.

1.4.2. Route

Ghinner - Goba

- Addis Ababa

Most traffic moving in and out of Ghinner goes direct to Goba and from there to Addis Ababa by truck or bus. About 100 passengers per month go to Ghinner and about the same number fly out. Ongoing freight traffic from Goba runs at about 2,000 kilos per month, consisting mainly of breakable manufactured goods, and drink. Out going freight is mainly of an agricultural nature, and flows at a rate of 800 kilos per month.

Traffic between Ghinner and Addis Ababa, via Goba, is about 23 passengers and 1000 kilos of frieght per month in each direction. Freight consists of Medical supplies, books and other delicate objects. In common with the Goba route, the passengers are mainly businessmen and students.

Seasonal fluctuations occur which cause shortages of space on some aircraft. These arise because of rains, harvests and shiftas, and normally occur during July, August and September.

A new road is being constructed to connect Ghinner with Goba. When this is completed much of the present traffic will be lost to bus companies and road hauliers. When the shifta Activities in the area cease, the army garrison in the town will presumably withdraw and the Airline should profit. After the withdrawal, passenger traffic should be maintained at a reasonably high level as people travel mainly for business reasons. When banks and other facilities come to Ghinner, people will not have to travel so much for business, but by that time more people will have money to travel for social purposes.

1.4.3. Route

Nasslo - Goba

- Addis Ababa

Travellers to Nasslo normally come from Addis Ababa or Goba. Perhaps 15 passengers/year travel between Ghinner and Nasslo, so for the present study these have been omitted. Traffic between Goba and Nasslo always goes by air, as there is no road, and averages 100 passengers/month in each direction. Normal freight to Nasslo consists of building materials, rifles and gasoline for the Army vehicles in the town. It averages 5,500 kilos per month and 4,500 kilos/month go on the return aircraft to Goba. This return freight consists of hides, coffee and agricultural produce. Passengers travel mainly for business reasons.

Passenger traffic between Nasslo and Addis Ababa is very limited, averaging 4 passengers/month, who again are either businessmen or students. Freight traffic shows no sign of any seasonal fluctuation and averages 450 kilos/month. Medical supplies and other delicate objects make up the greater part of the outgoing freight. Traffic on the outward aircraft to Nasslo averages 8 passengers and 250 kilos of freight /month.

Nasslo has no roads leading to it or from it, and so the future of the airline service is guarranteed. Expansion possibilities are good as the town recently aquired an army garrison, and natural economic growth has been relatively unhindered by shiftas. Traffic shows signs of a gradual expansion provided that shifta activity in the area does not increase.

2. Red Sea Region

2.1. Internal Airfields :- Addis Ababa, Dire Dawa, Assab, Massawa.

2.2. Internal Services :-

Outward

Aircraft	DC.6B	DC.6B	DC.6B	DC.6B	DC.6B	DC.3	DC.3
Cities	Mon.	Tues.	Weds.	Thurs.	Fri.	Sat.	Sun.
Addis Ababa	*	*	*	*	*	*	*
Dire Dawa	*	*	*	*	*	*	*
Assab		*				*	

Aircraft				DC.3.	DC.6B	DC.3	
Cities	Mon.	Tues.	Weds.	Thurs.	Fri.	Sat.	Sun.
Assab				*	*		
Asmara	*			*	*	*	
Massawa	*					*	

Internal Services (Continued)

Homeward

Aircraft	DC.3		DC.3		DC.6B DC.3	DC.3	
Cities	Mon.	Tues.	Weds.	Thurs.	Fri.	Sat.	Sun.
Massawa	*					*	
	|					|	
Asmara	*		*		* *	*	
			|		| |		
Assab			*		* *		

Assab		*				*	*
		|				|	|
Dire Dawa	*	*	*	*	*	*	*
	|	|	|	|	|	|	|
Addis Ababa	*	*	*	*	*	*	*
Aircraft	DC.6B	DC.6B	DC.6B	DC.6B	DC.3	DC.6B	DC.6B

2.3. General

Red Sea regional services are linked with international flights to Djiboute, Aden and Taiz. In the schedules shown above, most of these aircraft call at some foreign destination before or after their internal stops.

Prospects for Traffic expansion are good, as the war in the Yemen now seems likely to end, and the Imperial Ethiopian Government is putting money into the port of Assab. A new, and better international airport is planned for Assab, which might be included in the next five year plan. Also a new road to Assab is planned which, when completed, should make Ethiopia independent of the port of Djibouti in French Somaliland.

Roads in the region are good by Ethiopian standards, and even the dry weather trail between Assaband Massawa is passable for most of the year, although it vanishes into open scrub in places. Between Massawa and Asmara there is both a road and a railway. The distance is 115 km. and the train takes about 4 hours to steam up the hill to Asmara. The bus takes even longer. Massawa handles all the imports and exports of the northern region, and at present it is probably the largest port in the Empire. It is also an attractive holiday resort and attracts many tourists from all over the world.

Further south, road links between Assab and Addis are moderately good, and the new road between Awash and Mile will allow heavier traffic and cut down the journey time.

The Franco-Ethiopian railway connects Dire Dawa and Addis Ababa, as well as an excellent all-weather road. The train takes 12 hours to do the 452 km. to Addis Ababa, and the 1st class fare is a little less than the air fare. The second class fare is ½ the 1st class and the 3rd class is about ⅛th of the 1st class.

Daily buses connect Assab and Addis and Dire Dawa and Addis, charging 1/5th of the airfares.

Dire Dawa is a railway town, midway along the Franco-Ethiopian railway. It has a large European population as well as an airforce base and a palace. Air traffic between there and Addis Ababa could be expanded if gimmicks like cut price weekly return tickets were introduced.

2.4. Route:- Addis Ababa - Dire Dawa - Assab

This route is normally operated with DC.6B's and DC.3's. Aircraft normally continue to Djibouti after Assab, so low passenger figures on the Assab leg are not necessarily an indication of an unprofitable route. The daily flight to Dire Dawa carry about 18 passengers, and if the aircraft is flying on to Djibouti, perhaps another 10. The Dire Dawa passengers are a mixed bunch of business

Government Officials and people travelling for social reasons. The ratio is about 4 : 1 : 5 respectively. If cheap return tickets were offered on certain flights passenger traffic from the railway might go by air, and the ratio could be 4 : 1 : 9.

Freight traffic between Addis and Dire Dawa averages 11,000 kilos/month, which seems extremely good as the airline suffers stiff competition from the railway.

Two flights/week go from Addis to Assab, and 3 flights/week do the return journey. Both international and interal passengers disembark at Assab. Internal passengers from Addis average 37/month and freight from Addis runs at a rate of 650 kilos/month. On the return flights to Addis, an average of 56 passengers/month and 1,300 kilos of freight/month, travel by 2 DC.6B's and 1 DC.3. The freight consists mainly of fish.

Traffic between Dire Dawa and Assab averages 12 passengers and 3,000 - 4,000 kilos of freight/month and on the return flights to Dire Dawa, 16 passengers and 800 kilos of freight/month.

The future for this service looks extremely good. Traffic rose by over 20% last year and shows sign of maintaining this expansive trend. This is significant, because it is the route which has the fiercest competition from ground transport, and the airline seems to be winning.

2.5. Route:- Assab - Asmara

An average of 107 passengers and 1,366 kilos of freight travel every month from Assab to Asmara. The service is operated by 1 weekly DC.6B and 1 weekly DC.3 on the outward journey and 1 weekly DC.3 on the homeward journey to Assab. 98 passengers/month travel from Asmara to Assab, with an average of 8,947 kilos of freight/month. These are carried by 2 weekly DC.3's and 1 weekly DC.6B.

Future prospects seem bright, 1966 traffic was 10% up on 1965, and with government money and Russian aid both going into Assab, the airline cannot fail to expand its business. An increase at least of 10%/year on this route may be expected.

2.6. Route:- Massawa - Asmara

Little traffic goes to Massawa. All of it comes from Asmara and averages 92 passengers and 218 kilos of freight/month. The return traffic averages 98 passengers and 43 kilos of freight/month. 2 weekly DC.3's go in both directions.

Passengers are nearly always tourists, and the freight is generally mail.

Traffic on this route should expand, as more Ethiopians become affluent and take holidays on the coast. Competition from ground transport is fierce, but the train takes too long, and the bus passengers risk being molested by bandits as well as having to spend over 6 hours over the journey. On this type of route, with this sort of traffic, an expansion rate of 10 - 15% might be expected. This might be slightly less if all the bandits were cleared from Eritrea. The justification for this figure comes from the assumption that the world air traffic expansion rate of 10 - 15% applies to the tourist traffic on this route.

3. Northern Region

3.1. Airfields

Addis Ababa, Debra Marcos, Nota, Bahar Dar, Debra Tabor, Dessie, Lalibella, Makele, Axum, Asmara.

3.2. Services

International jet flights to Asmara

7 flights/week	Addis	Asmara
6 " "	Asmara	Addis Ababa

Continued/

Services (Continued)

Outbound

Aircraft	DC.3	DC.3	C.47	DC.3	DC.3	DC.3	DC.3
Cities	Mon.	Tues.	Weds.	Thurs.	Fri.	Sat.	Sun.
Addis Ababa		*	*	*	* *		*
Debra Marcos			*				*
Mota			*				*
Bahar Dar		*	*	*	*		*
Debra Tabor				*			*
Dessie					*		
Lalibella		*			*		
Gondar		*	*	*	*	*	*
Lalibella				*		*	*
Makele					*		
Axum	*				*	*	*
Asmara	*				*	*	*

Services (Continued)

Inbound

Aircraft	DC.3	DC.3	DC.3	DC.3		DC.3	DC.3
Cities	Mon.	Tues.	Weds.	Thurs.	Fri.	Sat.	Sun.
Addis Ababa	*	*	*	*		*	*
Debra Marcos			*				*
Mota			*				*
Bahar Dar	*	*	*	*			*
Debra Tabor				*			*
Dessie						*	
Lalibella							*
Gondar	*	*	*	*			*
Lalibella	*	*		*		*	
Makele	*						
Axum	* *					*	*
Asmara	* *					*	*

3.3. General

Most of the North bound traffic goes to Asmara, by EAL's jet flights. The rest go by DC.3 or C47 to the small stations en-route.

Good roads, and abundant bus services exist between all the stations en-route, with the exception of Mota and Lalibella. A new road is being constructed to Lalibella, but this is unlikely to affect airline passenger traffic, as most passengers are tourists without motor cars. Freight traffic will be affected. Operations to Lalibella cease during the rainy months of July, August and September. Mota is supplied entirely by air during the rainy season due to the absence of any all-weather road to the town. There is no prospects of any new road being built to Mota, and so its Airline service seems to have a sound future.

The Economics of the towns are varied, as are the passengers. Axum, Lalibella and Gondar are all Tourist Towns, Bahar Dar exists very profitably from the fishing industry from Lake Tana, and a Kharki Linen Factory. A paper factory and a new Airport are both planned for the town within the nest five years. The town has a Russian built Polytechnic, which attracts students from all parts of the Empire, and visiting lecturers from all over the world. Debra Marcos and Deora Tabor are both small towns, and a new road will soon link Debra Tabor with Gondar and Bahar Dar, which will reduce airline traffic to virtually nothing. Makele and Dessie are both provincial capitols to Tigre Province and Shoa Province respectively. Little traffic is generated by either of these cities, although some passenger and freight traffic exists at present between Dessie and Lalibella. There is some prospect of an increase in Traffic from Makele, as the town has just aquired several small factories and a large motor repair workshop. However most of the City's inhabitants are so poor that they cannot even afford to travel by bus.

The Northern region is more developed than the Western and Southern, although its land is less fertile. An examination of passenger trends in this region is very instructive, because it gives an indication of the likely traffic in the Southern and Western regions when they progress to their next stage of development. It also illustrates the dramatic fall in both passenger and freight traffic between 2 poor towns, when they are connected by road.

Bus fares may be assumed to be 1/5th of the air fares, and daily buses connect all large cities, schedules are based on the assumption that it takes 3 days from Addis to Asmara.

3.4. Route

Addis Ababa - Debra Marcos - Mota
Addis Ababa - Bahar Dar - Mota

Airline passenger travel on the Northern route is normally confined to the large towns of Addis, Gondar, Bahar Dar and Asmara. On the route shown above, Debra Marcos and Bahar Dar supply the small town of Mota, and the airline receives the benefit of passengers between Addis and Debra Marcos.

Addis - Debra Marcos	(Average:-	16	passengers	650	kilos	of	freight/month	
	(Maximum:-	25	"	1,687	"	"	" in 1	"
Debra Marcos - Addis	(Average:-	14	"	220	"	"	"	"
	(Maximum:-	23	"	500	"	"	"	"

Growth rate on this route should be 5% yearly.

Debra Marcos - Mota	(Average:-	45	passengers	788	kilos	of	freight/month	
	(Maximum:-	63	"	1,600	"	"	" in 1	"
Mota - Debra Marcos	(Average:-	45	"	50	"	"	"	"
	(Maximum:-	65	"	150	"	"	"	"

Growth on this route will stay around 10% annually, until the town gets an all-weather road to connect it with the outside world.

Bahar Dar - Mota	(Average:-	20	passengers	1,657	kilos	of	freight /month	
	(Maximum:-	28	"	5,028	"	"	in 1	"
Mota - Bahar Dar	(Average:-	20	"	153	"	"	"	"
	(Maximum:-	28	"	500	"	"	"	"

Growth on this route is being aided by urbanisation at Bahar Dar and will be further assisted by the new airport which is planned for Bahar Dar. A 20% annual increase in traffic may be confidently anticipated for the next three years at least, providing no new road to Mota is built.

Addis - Bahar Dar	(Average:-	1.4	passengers	1,731	kilos	of	freight /month	
	(Maximum:-	134	"	2,295	"	"	in 1	"
Bahar Dar - Addis	(Average:-	110	"	268	"	"	"	"
	(Maximum:-	106	"	185	"	"	"	April '66

Passenger traffic on this route grew by over 40% in 1966 and may be expected to maintain an average growth of at least 30% annually while Addis Ababa and Bahar Dar are developing so fast. Road developments cannot affect traffic, and the new paper mill and

airport developments at Bahar Dar should stimulate traffic even further.

Addis Ababa - Nota - 40 passengers and 1 ton of freight/year

Nota - Addis Ababa 40 passengers

Growth on this route should stay at the current rate of about 15% /annum.

Debra Marcos - Bahar Dar 60 passengers 200 kilos of freight/year

Bahar Dar - Debra Marcos 60 passengers /year

Growth may be anticipated at 13% /year.

3.5. Route

Addis Ababa - Gondar - Debra Tabor
Addis Ababa - Bahar Dar - Debra Tabor

Gondar - Debra Tabor (Average:- 29 passengers and 121 kilos of freight /month
(Maximum:- 72 passengers and 140 kilos of freight in July '66

Debra Tabor - Gondar (Average:- 23 " " 23 " of freight /month
(Maximum:- 58 " " 100 " of freight in August '66

Passengers on this route are mainly businessmen, and expansion prospects are poor as a new all-weather road will soon connect Debra Tabor with Bahar Dar and Gondar. Seasonal fluctuations in traffic are caused by the rains in July, August and September when the town is almost cut off. Growth will be low, probably less than 10% yearly.

Bahar Dar-Debra Tabor (Average:- 19 passengers 40 kilos of freight/month
(Maximum:- 43 " 50 " " " in August '66

Debra Tabor-Bahar Dar (Average:- 17 " 157 " " freight/month
(Maximum:- 46 " 116 " " in October '66

Businessmen constitute the bulk of the payload on this route. Expansion prospects are poor, on account of the new road which will shortly connect the two towns.

Addis - Gondar	(Average:-	88	passengers	2,80[illegible]	kilos	of freight/month
	(Maximum:-	125	"	3,199	"	" " in October'66
Gondar - Addis	(Average:-	92	"	563	"	" " /month
	(Maximum:-	138	"	951	"	" " in April '66

Passengers on this route are mainly tourists, with some businessmen and a few government officials. Expansion chances are good, and should be around 15% yearly. Gondar already has good road communications to the South, and traffic should be unaffected by any new roads. There is some hope that the expansion rate will exceed 15%/annum as the potential expansion rate of the foreign tourist industry is at least 30%/annum.

Bahar Dar - Gondar	(Average:-	46	passengers	184	kilos	of freight/month
	(Maximum:-	57	"	1,109	"	" " in Sept.'66
Gondar - Bahar Dar	(Average:-	21	"	79	"	" freight/month
	(Maximum:-	39	"	1	"	" " in April '66

Tourists, Businessmen, and a few Government officials make up the bulk of the passenger list. Urbanisation at Bahar Dar is progressing fast, so traffic expansion will be aided by this as well as growth in tourist trade and gross national product. Growth between 1965 and 1966 was almost 60%. This expansion rate will probably be maintained for the next 3 years at least.

Addis - Debra Tabor 80 passengers, 2 tons of freight/year.

3:6. Route

Asmara - Addis	(Average:-	845	passengers	17,379	kilos	of freight
	(					/month
	(Maximum:-	998	"	25,627	"	" freight in Dec.'66
Addis - Asmara	(Average:-	894	passengers	12,307	kilos	of freight
	(					/month
	(Maximum:-	1,023	"	14,493	"	" freight in Sept.'66

Traffic between Addis and Asmara is carried mostly by EAL's jets, all of which have either come from or are going to foreign places. Freight is normally a mixture of manufactured goods, from gold rings to toothbrushes. Mainly businessmen fly this route, but some tourists and government officials are normally on the passenger list. Expansion possibilities are excellent. Traffic increased by 20% in 1966, and should do the same again for many years to come, for two very good reasons. Both Addis and Asmara are urbanising quickly, and most of the country's development effort seems to be in building industries in these cities.

3.7. Route

Addis - Axum	(Average:-	10	passengers	139	kilos of freight/month	
	(Maximum:-	22	"	510	" " "	in July '66
Axum - Addis	(Average:-	9	passengers	6	kilos of freight/month	
	(Maximum:-	13	"	10	" " "	in Sept.'66

Passengers are almost always tourists and the freight is generally mail and oddments. Growth rate should be in the region of 15%/year but could be increased if the country's tourist industry was developed to its full potential.

3.8. Route

Lalibella - Addis	(Average:-	47	passengers	137	kilos of freight/month	
	(Maximum:-	76	"	80	" " "	in April'66
Addis - Lalibella	(Average:-	41	passengers	941	kilos of freight/month	
	(Maximum:-	63	"	366	" " "	in April'66

Operations to Lalibella are stopped during the rainy months of July, August and September. Passengers are always tourists, who normally go by aeroplane, in preference to the seasonal road which connects the town with Weldiya. A new road will shortly replace the present seasonal road, but this should not have much effect on existing traffic, other than slowing down the growth rate. The justification for this lies in the argument that tourist passengers do not have cars available and will continue to go by aeroplane. Traffic increased by 90% in 1966 and will probably rise by over 100% this year.

3.9. Route

Asmara - Gondar	(Average:-	38	passengers	919	kilos of freight/month	
	(Maximum:-	70	"	1,154	" " "	in Jan.'66
Gondar - Asmara	(Average:-	31	passengers	121	kilos of freight/month	
	(Maximum:-	75	"	133	" " "	in Sept.'66

Traffic is mainly generated by business, Government and tourist reasons in the ratio of 3: 1: 4 respectively. Growth rate should be about 15-20%/year, although this growth was not realised in 1966.

3.10 Route

Asmara - Lalibella	(Average:-	16	passengers	5	kilos of freight/month	
	(Maximum:-	36	"	2	" " "	in Jan.'66

Lalibella- Asmara (Average:- 20 passengers 12 kilos of freight/month
(Maximum:- 44 " " in Feb. '66

Passengers are normally tourists, and the growth rate should be between 50 - 80%/year. New road improvements around Lalibella should have less effect on this traffic than on traffic from Addis Ababa. When the tourist industry has developed to near its full potential, the growth rate should level to a steady 10%/year.

3.11 Route

Asmara - Axum (Average:- 26 passengers 202 kilos of freight/month
(Maximum:- 55 " 123 " " " "

Axum - Asmara (Average:- 47 passengers no freight/month
(Maximum:- 79 " in 1 month

Traffic on this route grew by over 80% in 1966. Most passengers are tourists and the mammoth increase reflects the growing popularity of Ethiopia to foreign visitors. This high growth rate should continue until the country's tourist appeal has been more fully exploited when a steady growth of 10% might be anticipated.

3.12 Route

Gondar - Lalibella(Average:- 63 passengers 585 kilos of freight/month
(Maximum:- 81 " 3,002 " " "in March '66

Lalibella - Gondar(Average:-112 passengers/year (no freight)

Traffic is mainly confined to tourists, seeing the country in the shortest possible time. Growth rate in 1966 was over 100%, and the usual arguments about unexploited tourist potential apply to this traffic. A high growth rate might be anticipated until a tourist saturation point is reached, when a steady annual increase of 10% may be expected.

3.13 Route

Lalibella - Axum (Average:- 43 passengers/month (no freight)
(Maximum:- 61 " in February, 1966

Axum - Lalibella (Average:- 6 passengers/month

Tourists are the only users of this service, and in 1966 their traffic increased on this route by more than 200%. This rate of growth should be maintained for several years to come until the tourist industry stops expanding.

3.14 Route

Addis - Makele 90 passengers/year

Growth rate 5%

3.15 Route

Asmara - Dessie 10 passengers/year

Growth rate 10%

3.16 Route

Axum - Bahar Dar 18 passengers/year

Growth rate 15%

3.17 Route

Axum - Gondar 90 passengers/year

Annual growth 60% until foreign tourist influx stops.

3.18 Route

Bahar Dar - Asmara 70 passengers 582 kilos of freight/year

Growth: 15% annually, despite disappointing figures in 1966.

3.19 Route

Bahar Dar - Lalibella 75 passengers/year

Growth: 90%/year until foreign tourist influx stops.

3.20 Route

Dessie - Addis 44 passengers/year

Growth: 8%/year

3.21 Route

Dessie - Lalibella 80 passengers/year

Growth: 5%/year

3.22 Route

Makele - Asmara 66 passengers/year

Growth: 5%/year

3.23 Route

Makele - Dessie 5 passengers/year

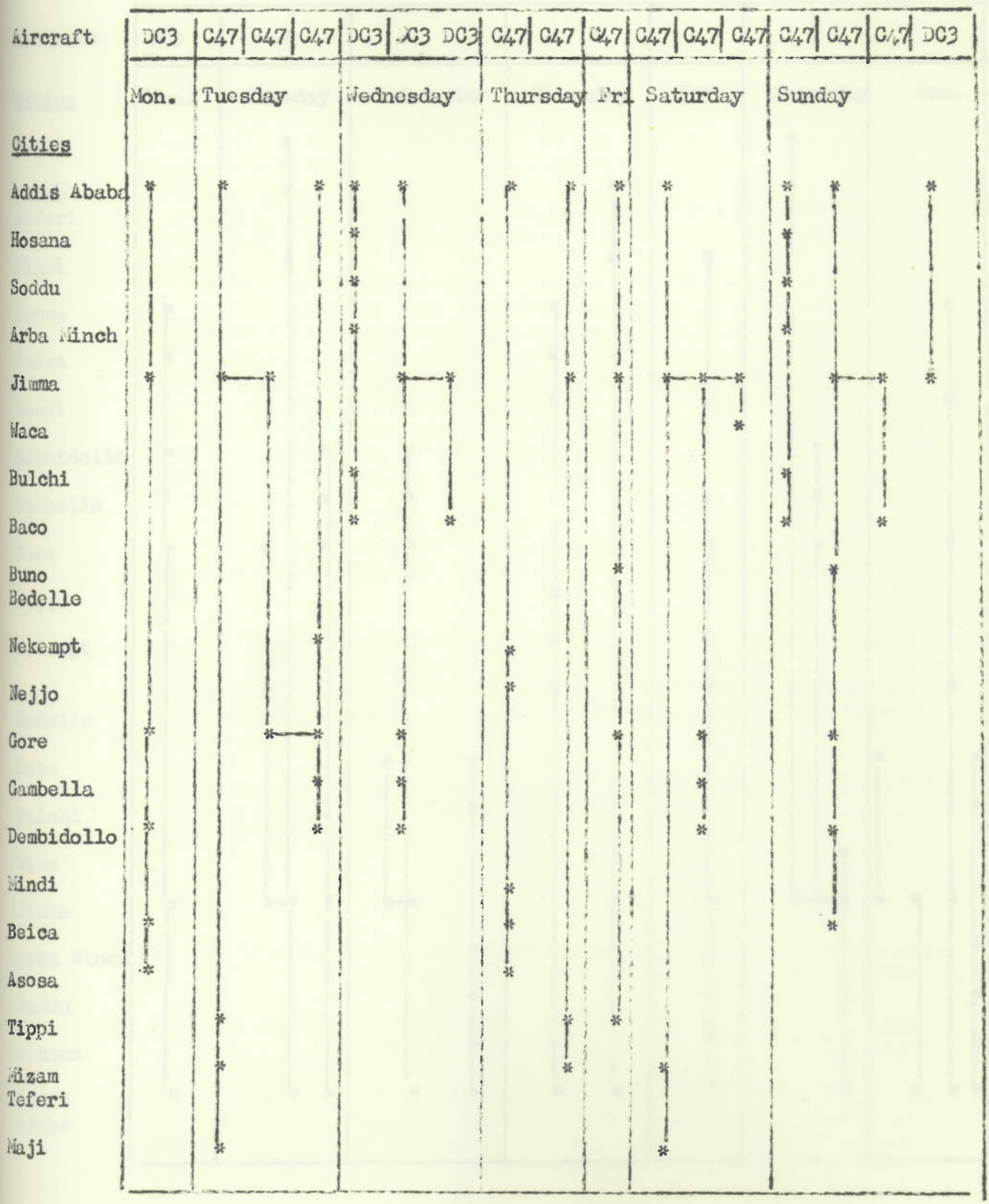
Growth: 8%/year (to the nearest passenger)

4. Western Region

4.1. Airfields:- Addis Ababa, Hosanna, Soddu, Arba Minch, Jimma, Waca, Bulchi, Baco, Buno Bedelle, Nekempt, Nejjo, Gore, Gambella, Dembidollo, Mendi, Beica, Asosa, Tippi, Mizan Teferi and Maji.

Continued/

4.2. Services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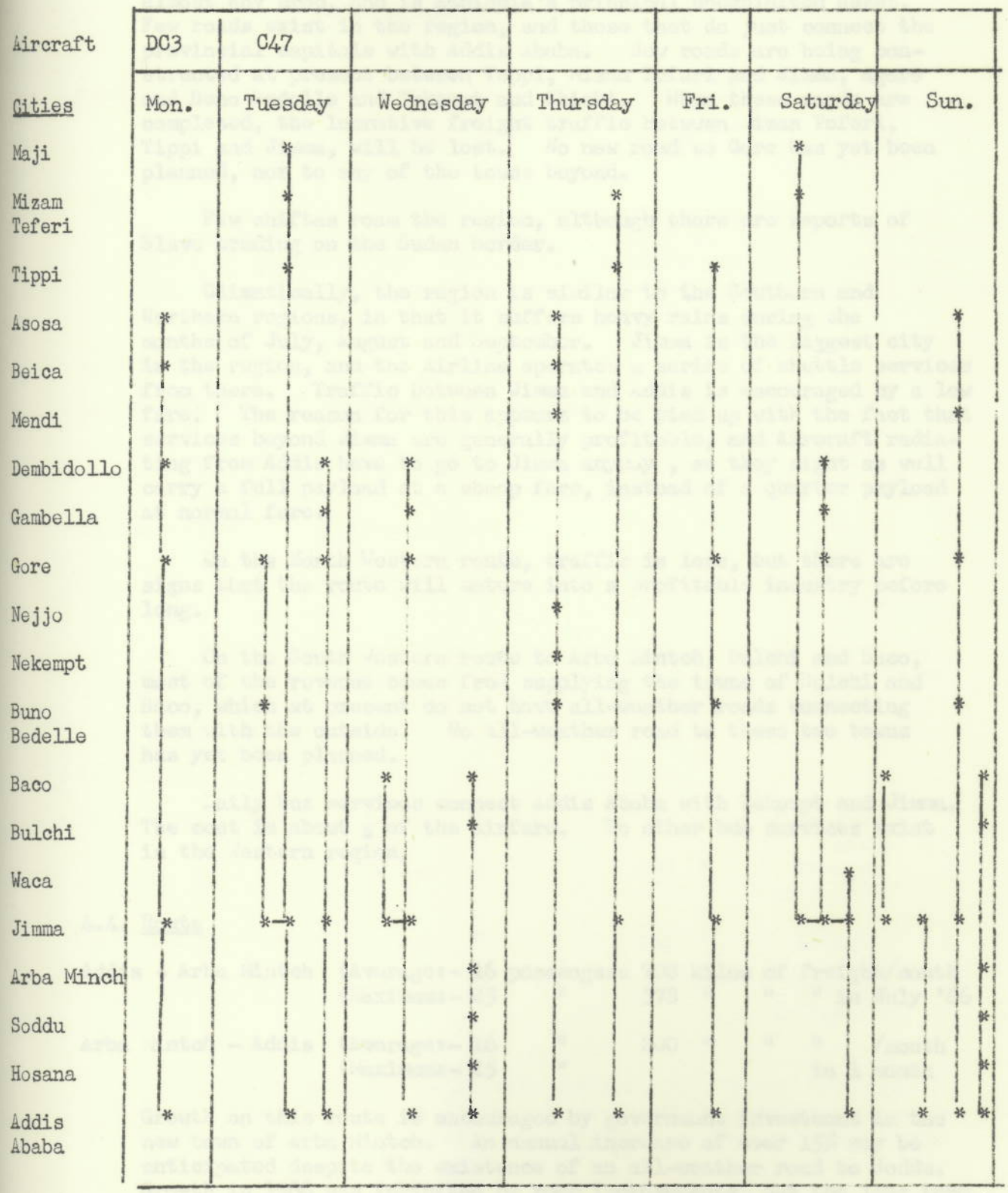
Services (Continued)



4.3. General

The Western region has very fertile soil, which will grow almost any crop, and is Ethiopia's principal unexploited asset. Few roads exist in the region, and those that do just connect the provincial capitals with Addis Ababa. New roads are being constructed at present between Teppi, Mizan Teferi and Jimma, Agaro and Buno Bedelle and Nekempt and Ghimbi. When these roads are completed, the lucrative freight traffic betwuen Mizan Teferi, Tippi and Jimma, will be lost. No new road to Gore has yet been planned, nor to any of the towns beyond.

Few shiftas roam the region, although there are reports of Slave trading on the Sudan Border.

Climatically, the region is similar to the Southern and Northern regions, in that it suffers heavy rains during the months of July, August and September. Jimma is the biggest city in the region, and the Airline operates a series of shuttle services from there. Traffic between Jimma and Addis is encouraged by a low fare. The reason for this appears to be tied up with the fact that services beyond Jimma are generally profitable, and Aircraft radiating from Addis have to go to Jimma anyway , so they might as well carry a full payload at a cheap fare, instead of a quarter payload at normal fare.

On the North Western route, traffic is less, but there are signs that the route will mature into a profitable industry before long.

On the South Western route to Arba Mintch, Bulchi and Baco, most of the revenue comes from supplying the towns of Bulchi and Baco, which at present do not have all-weather roads connecting them with the outside. No all-weather road to these two towns has yet been planned.

Daily bus services connect Addis Ababa with Nekempt and Jimma. The cost is about $\frac{1}{3}$ of the airfare. No other bus services exist in the Western region.

4.4. Route

Addis - Arba Mintch	(Average:-	16	passengers	708	kilos	of freight/month
	(Maximum:-	25	"	378	"	"	" in July '66
Arba Mintch - Addis	(Average:-	16	"	200	"	"	" /month
	(Maximum:-	25	"				in 1 month

Growth on this route is encouraged by government investment in the new town of Arba Mintch. An annual increase of over 15% may be anticipated despite the existence of an all-weather road to Soddu. Growth in 1966 was inhibited by road improvements, but the long term outlook is excellent.

4.5. Route

Addis - Baco	(Average:-	17	passengers	1,091	kilos	of freight /month
	(Maximum:-	32	"	2,311	"	" freight in Nov. '66
Baco - Addis	(Average:-	25	"	110	"	" freight /month
	(Maximum:-	37	"	53	"	" freight in March'66

Baco does not possess an all-weather road to the outside, and the function of the air service is to supply the town with the essentials of modern living. Growth may be anticipated as being below 10%, being dependent largely on the increase in gross national product.

4.6. Route

Addis - Bulchi	(Average:-	19	passengers	788	kilos	of freight /month
	(Maximum:-	33	"	430	"	" freight in Sept.'66
Bulchi - Addis	(Average:-	19	"	122	"	" freight /month
	(Maximum:-	28	"	121	"	" freight /in June'66

Bulchi is in a similar position to Baco, both with regard to road communications and economy. Growth rate again will be below 10% and dependent on increase in the Gross National Product.

4.7. Route

Addis - Buno Bedelle	(Average:-	36	passengers	930	kilos	of freight /month
	(Maximum:-	62	"	557	"	" freight in May '66
Buno Bedelle - Addis	(Average:-	39	"	152	"	" freight /month
	(Maximum:-	83	"	23	"	" freight in Sept.'66

Traffic to Buno Bedelle will decline when the new road from Jimma is completed. At least a 45% drop may be confidently anticipated followed by a small annual increase as the new road brings more wealth to the area.

4.8. Route

Addis - Dembidollo	(Average:-	90	passengers	2,243	kilos of freight /month
	(Maximum:-	126	"	2,138	" " freight in June'66
Dembidollo - Addis	(Average:-	89	"	384	" " freight /month
	(Maximum:-	142	"	192	" " "

No road developments which might affect Dembidollo have been planned, and so a fairly steady development, following the growth pattern of the district may be anticipated. The economic development of Dembidollo will probably be faster than of the country as a whole, because of the unexploited agricultural riches of the surrounding land. For this reason, a growth rate of around 10% annually is anticipated.

4.9. Route

Addis - Gambella	(Average:-	25	passengers	1,021	kilos of freight /month
	(Maximum:-	32	"	2,265	" " " freight in Nov.'66
Gambella - Addis	(Average:-	20	"	280	" " freight /month
	(Maximum:-	36	"	1,271	" " freight in Dec.'66

A growth rate of around 7% a year may be anticipated, unless more steps are taken by the E.T.O. to encourage tourists to hunt crocodiles there. The only other possibility of change in growth rate, would be an end to the civil war in the Souther Sudan, and the resumption of the steamer service along the river Baro.

4.10 Route

Addis - Gore	(Average:-	178	passengers	6,981	kilos of freight /month
	(Maximum:-	203	"	7,869	" " freight in May '66

Gore is an attractive City in Western Ethiopia, and the capital of the surrounding province. The agricultural wealth of the area is now beginning to be exploited, and this should encourage an airline traffic growth of 12% annually. If the tourist appeal of the town were exploited, this growth could rise to over 20% annually.

4.11 Route

Addis - Hosana	(Average:-	63	passengers	2,242	kilos	of freight /month
	(Maximum:-	82	"	3,668	"	" freight in Sept.'66
Hosana - Addis	(Average:-	64	"	352	"	" freight /month
	(Maximum:-	78	"	433	"	" freight in July'66

An annual growth of perhaps 5% may be assumed, until new all-weather roads connect the town with Addis Ababa and Wolamo Soddu. These roads are already under construction, and when completed they will take almost all the freight traffic and perhaps 50% of the passenger traffic. If the airline service is maintained, it can expect to grow annually by something less than 10%. There is however a faint hope that the considerable tourist appeal of Hosana will maintain a growth of more than 10% annually, but if this is to be the case the E.T.C. will have to be more active in publicising it.

4.12 Route

Addis - Jimma	(Average:-	337	passengers	17,159	kilos	of freight /month
	(Maximum:-	308	"	41,746	"	" freight in July '66
Jimma - Addis	(Average:-	402	"	3,378	"	" freight /month
	(Maximum:-	498	"	2,375	"	" freight in July '66

Traffic on this route is booming at present, particularly freight traffic. However, when certain western routes become unprofitable due to road improvements, the Airline may be forced to revise its fare structure, and the growth may be stunted. For the forseeable future, a growth in payload of 20% annually is likely. Most of this growth will probably occur in the freight traffic, as agricultural and manufacturing industries develop, and businessmen become more air-minded.

4.13 Route

Asosa - Bieca	(Average:-	29	passengers	378	kilos	of freight/month
	(Maximum:-	44	"	49	"	" " in June'66
Bieca - Asosa	(Average:-	43	"	1,175	"	" /month
	(Maximum:-	35	"	3,391	"	" in Nov.'66

Growth:- 5% per annum

4.14 Route

Baco - Arba Mintch	(Average:-	21	passengers	63	kilos	of	freight/month
	(Maximum:-	30	"	75	"	"	"	in 1 "
Arba Mintch - Baco	(Average:-	21	"	300	"	"	"	in 1 "
	(Maximum:-	30	"	1,000	"	"	"	in 1 "

Growth:- 5% annually

4.15 Route

Baco - Bulchi	(Average:-	20	passengers	543	kilos	of	freight/month
	(Maximum:-	122	"	71	"	"	"	in Aug.'66
Bulchi - Baco	(Average:-	74	"	847	"	"	"	/month
	(Maximum:-	88	"	1,379	"	"	"	in Sept.'66

Growth:- 5% annually

4.16 Route

Bulchi - Arba Mintch	(Average:-	27	passengers	87	kilos	of	freight/month
	(Maximum:-	46	"	no freight in November 1966				
Arba Mintch - Bulchi	(Average:-	27	"	500	"	of	freight/month
	(Maximum:-	44	"	1,500	kilos	"	"	in 1 "

Growth:- 5% annually

4.17 Route

Beica - Dembidollo	(Average:-	73	passengers	819	kilos	of	freight/month
	(Maximum:-	111	"	1,657	"	"	freight in Nov.'66	
Dembidollo - Beica	(Average:-	72	"	762	"	"	freight/month
	(Maximum:-	108	"	1,464	"	"	"	in 1 "

Growth:- 5% annually

4.18 Route

Buno Bedelle - Gore	(Average:-	60	passengers	546	kilos	of	freight/month
	(Maximum:-	84	"	720	"	"	"	in Sept.'66
Gore - Buno Bedelle	(Average:-	61	"	344	"	"	freight/month
	(Maximum:-	93	"	17	"	"	"	in March'66

4.18 Route (Continued)

When the new road to Buno Bedelle is completed, much of the traffic going from Jimma to Gore, will go from Buno Bedelle to Gore, and so an expansion of 10% annually is anticipated.

4.19 Route

Buno Bedelle - Jimma	(Average:-	60	passengers	4,009	kilos of freight /month	
	(Maximum:-	48	"	27,300	"	" freight in Aug. '66
Jimma - Buno Bedelle	(Average:-	55	"	5,686	"	of freight /month
	(Maximum:-	57	"	23,339	"	of freight in Aug. '66

The busy time for the airline occurs during the rainy season, when road communications are severed. When the new road between the two cities is completed, much of the present traffic will be lost and the total payload will probably go down to $\frac{2}{3}$ths of the present level. When things have settled, an expansion of 10% annually can be forseen.

4.20 Route

Dembidollo - Gambella	(Average:	4656	passengers	8,171	kilos of freight /month	
	(Maximum:-	65	"	9,656	"	" freight in March '66
Gambella - Dembidollo	(Average:-	47	"	420	"	" /month
	(Maximum:-	69	"	366	"	" freight in April '66

Traffic in 1966 showed a healthy expansive trend, and the present expansion rate of over 10% should be maintained.

4.21 Route

Dembidollo - Gore	(Average:-	35	passengers	812	kilos of freight /month	
	(Maximum:-	82	"	633	"	" freight in April '66

Growth should be maintained at the present level of over 13% annually, as the economies of both towns are expanding fast.

4.22 Route

Dembidollo - Jimma	(Average:-	28	passengers	146	kilos of freight /month
	(Maximum:-	46	"	15	" " freight in Aug.'66
Jimma - Dembidollo	(Average:-	12	"	1,147	" " freight /month
	(Maximum:-	10	"	2,251	" " freight in May '66

Expansion of traffic on this route should be in the region of 12% annually, although this figure was not recorded in 1966.

4.23 Route

Gambella - Gore	(Average:-	59	passengers	331	kilos of freight /month
	(Maximum:-	80	"	332	" " freight in April'66
Gore - Gambella	(Average:-	55	"	1,853	" " freight /month
	(Maximum:-	85	"	2,263	" " freight in Feb.'66

A 10% expansion annually can be forseen with confidence.

4.24 Route

Gore - Jimma	(Average:-	131	passengers	9,247	kilos of freight /month
	(Maximum:-	282	"	36,145	" " freight in July '66
Jimma - Gore	(Average:-	124	"	18,223	" " freight /month
	(Maximum:-	121	"	51,923	" " freight in July '66

Despite the fact that the new road to Buno Bedelle will make it more economical to ship freight there and then send it by road to Jimma, an expansion of 15% annually on air traffic between Gore and Jimja can be confidently anticipated. The reasons for this boom are many, but the most important, concerns the fast expansion of both cities and their importance in the administration of government in the Western region.

4.25 Route

Jimma - Mizan Teferi	(Average:-	80	passengers	14,003	kilos of freight /month
	(Maximum:-	79	"	36,464	" " freight in Aug. '66
Mizan Teferi - Jimma	(Average:-	82	"	29,364	" " freight /month
	(Maximum:-	58	"	47,902	" " freight in Aug. '66

Traffic is expanding by leaps and bounds, but this will soon be curtailed and reversed when the new road between Jimma and Mizan Teferi is completed. Almost all of the present freight traffic, and most of the passenger traffic will continue to use the air service After things have settled, an expansion of 20% annually can be expected.

4.26 Route

Jimma - Tippi	(Average:-	62	passengers	12,707	kilos of freight /month
	(Maximum:-	54	"	42,298	" " freight in July '66
Tippi - Jimma	(Average:-	68	"	75,891	" of freight /month
	(Maximum:-	89	"	191,071	" " freight in Jan. '66

Growth on this route will be stunted and reversed when the new road to Mizan Teferi and Jimma is opened. All freight traffic, and 8ths of the air passenger traffic will go by road. The remaining air traffic may be expected to expand by 20% annually.

4.27 Route

Mizan Teferi - Addis	137	passengers	15,336	kilos of freight/year
Addis - Mizan Teferi	135	"	5,400	" " " "

Growth rate: Passenger traffic 15% annually.
Freight traffic: A drop of 35% on completion of the new road thereafter an increase of 12% annually.

4.28 Route

Mizan Teferi - Tippi	(Average:-	24	passengers	455	kilos of freight/month
	(Maximum:-	23	"	2,977	" " " in Dec.'66

4.28 Route (Continued)

Tippi - Mizan Teferi (Average:- 22 passengers 1,182 kilos of freight /month
(Maximum:- 28 " 6,947 " " freight in Dec. '66

Traffic will decline on completion of the new road, and will probably stay at around ¼ of the present level.

4.29 Route

Addis - Soddu 62 passengers 2,098 kilos of freight/year

Soddu - Addis 64 " 1,038 " " " "

Traffic should either increase slowly or remain at the present level.

4.30 Route

Soddu - Baco 191 passengers 2,347 kilos of freight /year

Baco - Soddu 200 " 524 " " " "

Growth: 5% annually

4.31 Route

Soddu - Bulchi 441 passengers 8,274 kilos of freight/year

Bulchi - Soddu 445 " 1,024 " " " "

Growth: 6⅔% annually

4.32 Route

Waca - Jimma (Average:- 72 passengers 1,324 kilos of freight /month
(Maximum:-125 " no freight in June '66

Jimma - Waca (Average:- 73 " 1,157 kilos of freight /month
(Maximum:-123 " 247 " " freight in 1 month

Growth: 5% annually.

4.28 Route (Continued)

Tippi - Mizan Teferi (Average:- 22 passengers 1,182 kilos of freight /month
(Maximum:- 28 " 6,947 " " freight in Dec. '66

Traffic will decline on completion of the new road, and will probably stay at around ¼ of the present level.

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Baco - Soddu 200 " 524 " " " "

Growth: 5% annually

4.31 Route

Soddu - Bulchi 441 passengers 8,274 kilos of freight/year

Bulchi - Soddu 445 " 1,024 " " " "

Growth: 6⅔% annually

4.32 Route

Waca - Jimma (Average:- 72 passengers 1,324 kilos of freight /month
(Maximum:-125 " no freight in June '66

Jimma - Waca (Average:- 73 " 1,157 kilos of freight /month
(Maximum:-123 " 247 " " freight in 1 month

Growth: 5% annually.

5. Fares

Runway	Addis Ababa	Asmara	Dire Dawa
Asmara	105	-	124
Assab	105	74	50
Dire Dawa	55	124	-
Gondar	57	48	112
Jimma	20	125	75
	Eth.$	Eth.$	Eth.$

6. Condensed Airfield Information

Runway	Asosa	Assab	Bahar Dar
Latitude	10° 4'	13° 41'	11° 46'N
Longitude	34°32'	42° 38'	37 25'E
Elev.	5,260 ft.	40 ft.	6,030 ft.
Mean Temp. (Hottest Month)	-	34°	21°
Mean of Maxima of Same Month	-	38°	26°
Mean of Minima of Same Month	-	30°	15°
Yearly Mean	-	30°	18°
Runway (feet)	2,450 ft.	4,304 ft.	4,900 x 197 ft.
Surface	Dark brown organic clay	Volcanic Ash	Turf
Stopway	-	SE end 600ft. NW end 400ft.	-
Orientation	-	-	180 - 360
Average Slope	-	Zero	-
Max. Slope.	-	-	-

Condensed Airfield Information (Continued)

Obstacles

Asosa: Both approaches are clear of obstacles above a slope of 1:50.

Assab: The N.W. approach surface is clear above a gradient of 1:50 for a distance in excess of 3,000 metres. The S.E. approach surface is obstructed by a ridge, 1 km. from the end of the runway and 30 metres high. This ridge is particularly hazardous as its south western end curves round towards the runway, rises and then joins a small hill. The small hill is situated 680 metres south of the runway and is 37 metres high. The clear approach surface has a gradient of 1:26:5, but most pilots do not fly over the curved portion of the ridge, and on this approach line, the ridge restricts approaches to a gradient of 1:33.

Bahar Dar: The south approach is clear above a slope of 1:50 for a distance in excess of 3,000 metres. Minimum unlimited clear slope, fixed by a distant peak is 1:32. The north approach surface of 1:50 slope is penetrated by a tree, a small outbuilding Bahar Dar School and a power line. The clear approach is restricted to 1:25.

Condensed Airfield Information (Continued)

Runway	Axum	Ghinnor	Masslo	Asmara
Latitude	14° 07'N	07° 09'N	6° 21'N	15° 18'N
Longitude	38° 43'E	40° 43'E	39° 43'E	38° 55'E
Elev.	7,000 ft.	6,500ft.	5,000 ft.	7,628 ft.
Mean Temp. (Hottest Month)	-	-	-	18.1
Mean of Maxima Same Month	-	-	-	25.7
Mean of Minima Same Month	-	-	-	11.5
Yearly Mean	-	-	-	16.1
Runway	4,950	4,092	3,680	Runway 1 6,420 ft. Runway 2 6,940 ft.
Surface	Poorly drained grass	Turf	Dray Clay and Turf	Bitumous
Stopway	N.W. end 184 ft. S.E. end 540 ft.	S.E. end 175 ft.	East end 350ft. West end 200ft.	
Orientation	120° 300°	50° 130°	100° 260°	119°229° 74°254°
Average Slope	1.09% N.W. higher than S.E.	2.62% N.W. higher than S.E.	0.6%	0.6% 0.4%
Maximum Slope	1.75%		3.2% for 600 ft. at East end	1.2% 1.0%

Obstacles Axum: The S.E. approach surface is clear above a gradient of 1:50 for a distance in excess of 3,000 metres. The N.W. approach is obstructed by two mountains, one in line with the runway. The other is not directly in line with the runway, being N.N. West and 7,300 ft. from it. Its elevation is 480 ft. above the runway level. Fortunately, the summit of the first mountain is not directly in line with the runway, and the gradient of a direct approach surface 1,000 ft. wide is restricted to 1:17:8. However, by flying between the mountains and straightening up for the runway, an approach surface gradient

Condensed Airfield Information (Continued)

Obstacles

Ginner: The South Eastern approach surface is clear above a gradient of 1:50 for a distance in excess of 3,000 metres. The Northwest approach surface of 1:50 is penetrated by buildings 500 ft. from the runway end and bushes 400 ft. from the runway end. The clear approach surface is restricted to a gradient of 1:18:2 although by loosing a few hundred feet of runway length, an approach surface gradient of 1:50 can easily be realised.

Masslo: The Eastern approach surface is clear above a gradient of 1:50 for a distance in excess of 3,000 metres. The western approach surface is obstructed by a high terrain, about 1 km. from the runway end, limiting the approach surface to a slope of 1:34. It was impossible to fix the exact position of this terrain, as our armed escort would not permitt us to penetrate the forest and make a baseline for a survey.

Asmara: Runway 1. 12 30

Approaching on 120°, a few trees protrude into the approach surface, otherwise it is clear. Approaching on 300°, there are three obstructions - a ridge 2½ km. away, trees and telephone wires. The approach angle is limited to 1:40.

Runway 2. 07 25

Approaching on 70°, completely clear. Approaching on 250° there are two obstacles - a tree at the runway end and high terrain 250 metres from the runway end.

Condensed Airfield Information (Continued)

Runway	Beica	Callafu	Callan	Donghilla
Latitude	9° 23'E	5° 40'N	4° 58'N	11° 16'N
Longitude	34° 32'N	44° 15'E	35° 58'E	36° 57'E
Elev.	5,420 ft.	854 ft.	1,511 ft.	7,090
Mean Temp. (Hottest Month)	21°C	29°C	29°C	18°C
Mean of Maxima of Same Month	31°C	34°C	34°C	27°C
Mean of Minima of Same Month	19°C	23°C	23°C	11°C
Yearly Mean	23½°C	28°C	27°C	17°C
Runway	3,585 ft. x 138 ft.	3,710 ft. x 197 ft.	2,790 ft.	4,000 ft. x 204 ft.
Surface	Turf	Silt and Clay	Desert Silt	Turf
Stopway	-	-	-	-
Orientation	150 - 330 true	160 - 340 true	40 - 220 true	180 - 360 true
Average Slope	1.36%	-	-	-
Maximum Slope	2.7% S.End	-	-	-

Obstacles

Beica: Both approaches are clear above a gradient of 1:50 for a distance in excess of 3,000 metres.

Callafu: Southern approach surface clear above a slope of 1:50 for a distance in excess of 3,000 meters, except for scattered trees and low bush. Northern approach surface of 1:50 is penetrated by hills 3 km. north of runway end. These obstructions restrict the approach surface to 1:30. An escarpment 4 km. north of runway and restricts the clear slope to 1:24.

Condensed Airfield Information (Continued)

Obstacles	Callam:	Both approaches clear of obstacles for approach surfaces of 1:50 for a distance in excess of 3,000 meters.
	Danghilla:	Both approaches clear of obstacles for approach surface of 1:50 for a distance in excess of 3,000 meters, except for some high thorn bushes at the northern end.

Runway	Debra Marcos	Debra Tabor	Dessie	Dilla
Latitude	10° 20'N	11° 55'N	11° 04'	6° 25'N
Longitude	37° 46'E	38° E	39° 43'E	38° 16'E
Elev.	8,140 ft.	8,500 ft.	6,380 ft.	5,580 ft.
Mean Temp. (Hottest Month)	22°C	16°C	20°C	21°C
Mean of Maxima of Same Month	29°C	25°C	24°C	29°C
Mean of Minima of Same Month	15°C	10°C	13°C	14°C
Yearly Mean	19°C	15°C	18°C	20°C
Runway	4,921 ft. x 141 ft.	4,190 ft. x 246 ft.	3,960 ft. x 165 ft.	3,450 ft. x 165 ft.
Surface	Turf (bad drains)	Turf	Asphalt	Soil
Stopway	-	-	-	-
Orientation	160 - 340	180 true	45 - 225 true	150 - 330 true
Average Slope		0.95% S. higher than N.	3.11% S.W. higher than N.E.	1.21% S.E. higher than N.W.
Maximum Slope	-	3.2%	3.6%	-

Condensed Airfield Information (Continued)

Obstacles	Debra Marcos:	Southern approach surface is clear above a slope of 1:50 for a distance in excess of 3,000 meters. North approach, also clear above a slope of 1:50, except for trees located 140 meters from end of runway. These trees penetrate the approach surface by 18 meters, and have a top elevation of 2,487 meters.
	Debra Tabor:	The north approach surface is clear above a slope of 1:50 for a distance in excess of 3,000 meters. The south approach surface is obstructed by a peak 2,300 meters from the runway end, allowing a min. clear slope of 1:20. Landings are made only from the north, and take-offs only to the north.
	Dessie:	North east approach surface is clear above a slope of 1:50 for a distance in excess of 3,000 meters, although more distant peaks reduce the unlimited clear slope to a figure substantially below this. The S.W. approach is obstructed by a mountain of elevation 2,192 meters, which allows a clear slope of only 1:9.
	Dilla:	North Western approach surface is clear above a slope of 1:50. The South eastern approach surface of 1:50 slope is penetrated by a peak about 1,250 meters south of the runway which reduces the slope of the clear approach surface to 1:34.

Condensed Airfield Information (Continued)

Runway	Dire Dawa	Gambella	Gardulla
Latitude	9° 38'N	8° 17'N	5° 29'N
Longitude	41° 52'E	34° 35'E	37° 30'E
Elev.	3,180 ft.	1,768 ft.	4,180 ft.
Mean Temp. (Hottest Month)	27.9°C	29°C	23°C
Mean of Maxima of Same Month	34.8°C	38°C	29°C
Mean of Minima of Same Month	21.0°C	20°C	17°C
Yearly Mean	24.7°C	26°C	21°C
Runway	-	3,120 ft. x 132 ft.	3,626 ft. x 237 ft.
Surface	Concrete	Light Sandy Clay (poorly drained)	Turf
Stopway	-	-	-
Orientation	152 - 332	170 - 350 true	330
Average Slope	1.82%	0.6% N. higher than S.	0.83% NW. higher than SE.
Maximum Slope	1.95%	2.7%	-

Obstacles

Dire Dawa: On the north approach surface is clear without limit above a slope of 1:50. On the south the approach surface is clear to a distance of 3,500 metres at which an isolated peak reduces the clear slope to 1:31.

Gambella: The south approach surface is clear above a slope of 1:50 for a distance in excess of 3,000 meters except for the radio masts which penetrate its eastern edge. The north approach surface is obstructed by a mountain peak about 2,700 meters from the

Condensed Airfield (Continued)

Obstacles

runway end. The clear approach surface is 1:18. This results in a single ended use of the runway.

Gardulla: The south approach surface is clear above a slope of 1:50 for a distance in excess of 3,000 meters, except for some brush and a few scattered trees. The north approach surface is obstructed by a high peak, which limits the slope of the clear approach surface to 1:15. Another peak, to the north-west, less than 3 km. from the runway, protrudes above the horizontal surface.

Runway	Gimbi	Goba	Gondar
Latitude	9° 12'N	7°	12° 31'N
Longitude	35° 47'E	01'	37° 25'E
Elev.	6,[illegible]0 ft.	[illegible],000 ft.	6,690 ft.
Mean Temp. (Hottest Month)	22°C	12°C	21°C
Mean of Maxima of Same Month	29°C	20°C	28°C
Mean of Minima of Same Month	15°C	6°C	13°C
Yearly Mean	19°C	11°C	18°C
Runway	2,790 ft.	3,955 ft.	4,780 ft. x 165 ft.
Surface	Turf (Clay Soil)	Turf (Muddy Soil)	Turf
Stopway	-	NW. end 1,000 ft. - gradient 5%, surface - coarse grass	
Orientation	80 - 260	40 - 220 true	170 - 350
Average Slope	-	2.6% S.E. higher than N.W.	1.8% N. higher than S.
Maximum Slope	-	2.9%	3.12%

Condensed Airfield Information (Continued)

Obstacles

Gimbi: The western approach surface is clear above a slope of 1:50 for a distance in excess of 3,000 metres. Towards the east, terrain slopes upward, limiting the clear approach surface to 1:10.

Goba: The north-eastern approach surface is clear above a slope of 1:50 for a distance in excess of 3,000 metres. The S.W. approach is obstructed by houses on a low ridge about 250 metres from the end of the runway which restricts the clear approach surface to a slope of 1:6. Further away about 6 km. to the S.W. a mountain range, 650 metres higher than the runway constitutes an additional hazard. Due to these obstructions the runway is generally used single endedly. All landings are toward the southwest and T.O's to the northwest.

Gondar: Due to the presence of a low, weathered-rock hill, reaching a height of 21.5 metres above the north end of the existing runway, current use of this runway is single ended only. The south approach surface is clear above a slope of 1:50 for an unlimited distance.

Condensed Airfield Information (Continued)

Runway	Harar	Hosana	Jimma	Lekempti Airport
Latitude	9° 22'	7° 33'N	7°40'N	9° 05'N
Longitude	42° 07'	37° 52'E	36°48'E	36° 33'E
Elev.	6,240 ft.	7,600 ft.	5,510 ft.	7,220 ft.
Mean Temp. (Hottest Month)	21°C	16°C	21°C	20°C
Mean of Maxima of Same Month	26°C	24°C	27°C	26°C
Mean of Minima of Same Month	15°C	80°C	14°C	15°C
Yearly Mean	20°C	15°C	19°C	18°C
Runway	4,799 ft. x 400 ft.	3,222 ft. x 174 ft.	6,290 ft.	4,083 ft.
Surface	-	Grass	Asphalt	Grass
Stopway	-	-	West end 300 ft. East end 200 ft.	N.W. end 300 ft. S.E. end 250 ft.
Orientation	150 - 330	160 - 340	125 - 305	315 - 135
Average Slope	1.3% N.W. higher than S.E.	1.2% N.W. higher than S.E.	0.15%	3.7% N.W. higher than S.E.
Maximum Slope	1.8%	-	0.40%	4%

Obstacles

Harar: Existing approach conditions are:-
The S.E. aproach surface is clear above a slope of 1:50 for a distance in excess of 3,000 metres except for trees at the end of the runway.
The N.W. approach surface is penetrated by a ridge about 2 km. from end of runway. This obstruction restricts the clear approach surface to a slope of 1:37. A more distant ridge approx. 4,800 metres from the end of the runway limits the clear slope to 1:17. Due

Condensed Airfield Information (Continued)

Obstacles

to these obstructions the runway will be mainly single ended.

Hosana: Except for a few scattered trees at the runway end zones, both approach surfaces are clear above a slope of 1:50 for a distance in excess of 3,000 metres.

Jimma: Approaching from the southeast the approach surface is clear indefinitely above a slope of 1:50. Approaching from the northwest, the approach surface is clear, except for trees, above a slope of 1:50 for a distance of 8 km, where a ridge crosses the prolongation of the runway axis. A line joining the runway extremity with the ridge top has a slope of 1:29.

Lekempti Airport: Both approach surfaces are clear of obstacles above a slope of 1:50 for distances in excess of 3,000 metres.

Condensed Airfield Information (Continued)

Runway	Maji	Makele (not present site)	Massawa
Latitude	[illegible]° 50'N	13° 28'N	15° 36'N
Longitude	35° 34'E	39° 31'E	39° 26'E
Elev.	2,500 ft.	7,320 ft.	32.9 ft.
Mean Temp. (Hottest Month)	30°C	19°C	34.7°C
Mean of Maxima of Same Month	40°C	27°C	38.9°C
Mean of Minima of Same Month	21°C	12°C	28.9°C
Yearly Mean	26°C	17°C	30.0°C
Runway	[illegible] ft.	4,175 ft.	6,190 ft.
Surface	Turf	Turf	Salt stabalised, compacted, crushed, aggregate surface coarse
Stopway	-	-	-
Orientation	150 - 330	110 - 290	159 - 339
Average Slope	1.75% N.W. higher than S.E.	0.46% N.W. higher than S.E.	0.46% N.W. higher than S.E.
Maximum Slope	-	-	-

Obstacles

Maji: Except for trees at the runway ends, both approach surfaces are clear above a slope of 1:50 for a distance in excess of 3,000 metres.

Makele: Both approach surfaces are clear above a slope of 1:50 for a distance in excess of 3,000 metres. However, the Makele Quiha road passes less than 10 metres from the

Condensed Airfield Information (Continued)

Obstacles	western end constitutes a hazard.
Massawa:	South end of runway is only 400 metres from the salt drying beds near the Occ n shore. In the intervening space a distance of 80 metres from the runway end a railway line and a road cross the prolongation of the runway at Rt.L's. Except for these obstructions a clear approach surface of 1:50 can be realised for over 25 km. this end. At the north end 5 hazards in 600 metres, starting 160 metres from runway end, viz: a road, railway, bucket conveyer cableway, telephone line, high voltage power line. The clear approach surface over these hazards has a slope of 1:35 whereas with the removal of the cableway and pole lines, a slope of 1:50 can be reali ed.

Condensed Airfield Information (Continued)

Runway	Mizam Teferi	Soddu	Tesseni	Tippi
Latitude	6° 58'N	6° 50'N	15°07'	7° 20'N
Longitude	35° 32'E	37° 45'E	36°41'	35° 35'E
Elev.	1,117 ft.	6,400 ft.	2,020 ft.	4,170 ft.
Mean Temp. (Hottest Month)	24°C	20°C	35°C	24°C
Mean of Maxima of Same Month	28°C	26°C	41°C	28°C
Mean of Minima of Same Month	19°C	14°C	26°C	19°C
Yearly Mean	21°C	18°C	30°C	21°C
Runway	4,130 ft.	3,314 ft.	4,270 ft.	4,170 ft. x 263 ft.
Surface	Turf(bad in rains)	Turf	Desert silt and grass, badly drained	Earth and Turf
Stopway	-	N.E.end 250ft. S.W.end 1,100ft. of soft grass and earth		-
Orientation	60 - 240	50 - 230	130 - 310	130 - 310
Average Slope	2.75% N.E.higher than S.W.	1.67% N.E.higher than S.W.	0.36% S.E.higher than N.W.	3.28% N.W.higher than S.E.
Maximum Slope	-	-	-	-

Obstacles

Mizam Teferi: The western approach surface is clear above a slope of 1:50 for a distance in excess of 3,000 metres. A high ridge on the east restricts the eastern approach surface to clear slope of 1:10, making landings and take-offs from and to that direction impossible.

Condonsed Airfield Information (Continued)

Runway	Gore	Dembidollo	Addis Ababa (old airport)	Arba Mintch
Latitude	8° 10'N	8° 33'N	9° N	6° 04'N
Longitude	35° 33'E	34° 52'E	38° 44'E	37° 40'E
Elev.	6,580 ft.	5,190 ft.	7,750 ft.	4,000 ft.
Mean Temp. (Hottest Month)	21°C	25°C	18.4°C	-
Mean of Maxima of Same Month	29°C	29°C	26.2°C	-
Mean of Minima of Same Month	15°C	20°C	10.5°C	-
Yearly Mean	19°C	22°C	16.4°C	-
Runway	2,955 ft. x 148 ft.	3,300 ft. x	5,660 ft. x 148 ft.	3,930 ft.
Surface	Turf	Turf (bad drains)	Bitumous	Coarse grass and earth
Stopway	-	N.W.end 50ft. S.E.end 350 ft.	377 ft. loose grit	N.W. & W 300ft. S.E.x E. 260 ft.
Orientation	30 - 21[illegible]	146 - 236	122 - 302	286°
Average Slope	2.1[illegible] [illegible]. higher than N.	1.36% S.E.higher than N.W.	1.21%	.4% S.E.higher than N.W.
Maximum Slope	3.0%	3.7%	1.60%	-

Obstacles

Gore: On the north the approach surface is clear and indefinitely above a slope of 1:50. On the south the clear approach surface is restricted to a slope of 1:24 by the trees on the rocky outcrop which abuts the runway. Removal of trees will improve the slope to 1:30.

Condensed Airfield Information (Continued)

Obstacles

Sodda: The southwest approach surface is clear above a slope of 1:50 for a distance in excess of 3,000 metres. The northeast approach is obstructed by a low ridge, with high trees, and the clear approach surface is restricted to 1:30. In addition the strip functions single endedly, with landings to the N.E. and T.O's to the S.W.

Tosseni: The south eastern approach is clear above a slope of 1:50 in excess of 3,000 metres except for a lone tree and some scattered brush. The northwest approach surface is obstructed by barrack building power and telephone lines and a flagpole. Maximum clear slope fixed by these obstructions is 1:39.

Tippi: No terrain obstacles, trees at both ends of runways, on account of location in the middle of a rain forrest.

Condensed Airfield Information (Continued)

Obstacles

Dembidollo: Both ends clear to an approach surface of 1:50.

Addis Ababa: The approach zone at S.E. entirely free of obstacles above a surface of 1:50. The approach from the N.W. is hindered by a ridge of approx 2,630 metres elevation lying 560 metres from the runway end. The slope of the line joining the runway extremity to the top of the ridge is 1:21. Approaches from N.W. are commonly attempted only when atmospheric conditions are good and visibility high.

Arba Mintch: The approach surface at the S.E. end is limited to a gradient of 1:22 by a mountain near the end of the runway. By banking slightly, the peak of the mountain can be avoided, and an approach gradient of 1:30 can be realised. The Northwest approach surface is obstructed by a mountain close to this end of the runway, making the runway single ended.

PART II

GEOLOGICAL MAPPING

PRELIMINARY REPORT

- by -

J. HARRIS

INTRODUCTION

On the advice of Dr. I.L. Gibson and Dr. W. Padgam of the Geology Department Haile Sellassie II University, Addis Ababa, an area to the south of Dira Dawa was selected for geological investigation.

Dira Dawa lies in the province of Harrar, E. Ethiopia, about 35 km. north of the provincal capital Harrar. The town was built by the French at the turn of the century during the construction of the Djibouty-Addis Ababa railway.

Immediately to the south of Dira Dawa a series of step faults raise the land surface from 1,207 m. at Dira Dawa to 2,500 m. on the plateau land to the south. These faults form the southern boundery of the Afar Depression, which is part of the great East African Rift System.

The area mapped is one of moderate relief, with a series of approximately east-west homoclinal ridges of limestone each with a steep scarp slope facing north and a dip slope facing south. Between the ridges are flat floored valleys, usually occupied by sandstone. Further south the underlying basement rocks are brought to the surface and the land rises very steeply up to the Harrar plateau.

Cutting across the strike of the country are a series of dry rivers (wadis), some of which are very wide and provide convenient routes into the area.

The climate is hot and arrid, and the vegitation is restricted to cactus and thorn scrub. Exposure is practically 100 per cent on the limestone ridges, but the valleys are often blanketed by sands and gravels.

The area was mapped on aerial photographs, on a scale of 1:20,000, which were purchased from the Imperial Highway Authority. A total of seven weeks were spent on the project, five weeks in the field and two weeks seeking official permission to work and buy the aerial photographs. The work was done on foot from base camp in Dira Dawa.

This area is of particular interest for the following reasons:

Reconnaissance mapping has shown the presence of a series of small intrusions of a fine grained whitish rock, the form, mode of intrusion and petrology of which was unknown. Rocks of a similar aspect have been found as xenoliths in volcanic rocks to the south-west.

The area has not been mapped in detail before.

Geological History

A basement complex of Precambrian schists and gniesses is overlain by Mesozoic marine sediments. The sediments of the Dira Dawa area are Jurassic. They consist of a lower series of limestones, sometimes seen lying directly on the basement rocks and sometimes separated by thin conglomerates and sandstones; the basal Adigrat sandstones are apparently missing in this area. Above the limestones is a sandstone series.

In the Upper Eocene Ethiopia was affected by the Arabo-Ethiopian swell, along which the Rift Valley developed.

The sediments of the Dira Dawa area were cut by a series of small intrusions, mentioned above: possibly during the phase of rifting. Basaltic dykes and sills were also intruded along faults.

The rocks will be described in stratigraphic order:

1. Crystalline Basement

The rocks of the crystalline basement are generally believed to be of Precambrian age. Rocks of the basement crop out in only two small areas in the area mapped. They are well exposed and accessable along the road from Dira Dawa to Harrar and these were briefly studied.

Although the road side exposure is good, the Precambrian rocks are everywhere very deeply weathered. Immediately beneath the Mesozoic sediments the Precambrian is weathered to a depth of twelve feet or more, evidence of a considerable period of exposure to weathering before the Mesozoic.

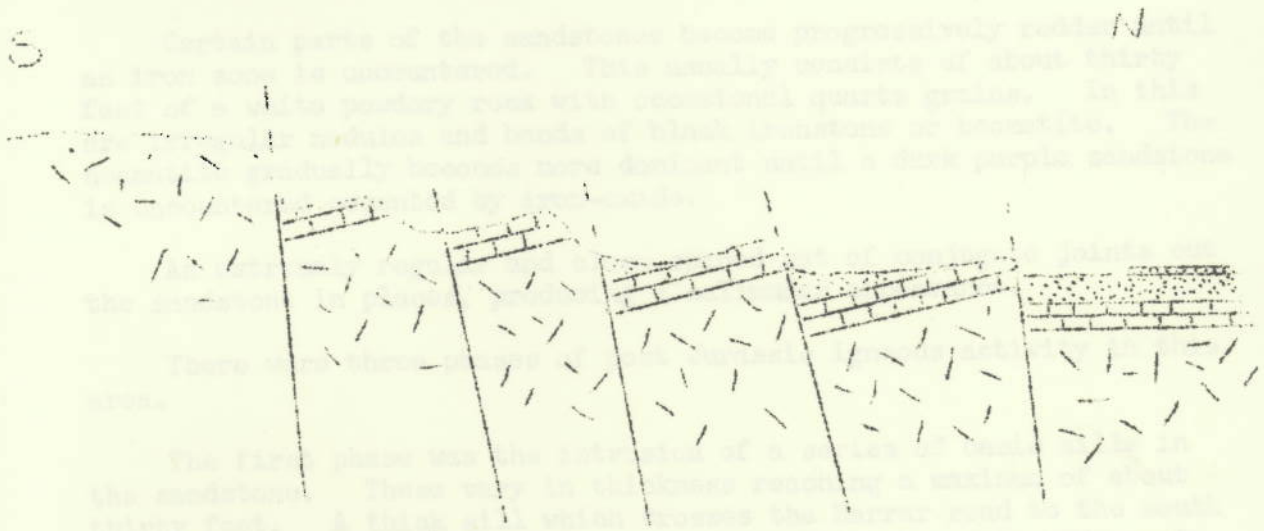
The basement is chiefly composed of a coarse foliated gniess, intruded by unfoliated granites. The gniess is composed of interlayered white quartz feldspar bands and darker biotite rich bands with occasional very deeply weatherd amphibolite bayers. The whole is cut by ubiquitous pegmatite veins, usually folded into complex ptigmatic folds. Irregular minor folds, boudinage etc., is seen in the darker bands.

Specimens suitable for thin section are difficult to find due to the extreme weathering of the rocks.

2. Mesozoic Sediments

A marine transgression which reached its maximum extent in Ethiopia in the middle Jurassic, resulted in the deposition of a series of limestones were deposited. The basement - limestone unconformity is not exposed in many places, in some places the limestone lies directly on the basement while elsewhere they are separated by up to thirty feet of conglomerate and sandstone.

DIAGRAMMATIC SECTION.



The limestone is mostly a massive, grey and crystalline, it is shelly in parts, with irregular calcite filled vugs and chert lenses towards the top. Lower down there is a considerable thickness of oolitic limestone. At the top is a yellow muddy limestone which is very fossiliferous. The fossils found include brachiopods, lamellibranchs, belemnites and corals in the limestone and large ammonites, echinoids, belemnites, brachiopods and lammellibranchs in the muddy limestone.

The muddy limestone passes up into the sandstone formation. The sandstone occurs in flat bottomed valleys between the limestone ridges. It is mostly yellow-red in colour, it is coarse with grains up to $\frac{1}{2}$ in. in diameter. Grading and cross bedding occurs in sets 2 ft. or so thick. Except where they have been recrystallised by igneous intrusives, the sandstones are mostly poorly cemented. They are unfolliliferous.

Certain parts of the sandstones become progressively redder until an iron zone is encountered. This usually consists of about thirty feet of a white powdery rock with occasional quartz grains. In this are irregular nodules and bands of black ironstone or heamatite. The heamatite gradually becomes more dominant until a dark purple sandstone is encountered cemented by iron-oxide.

An extremely regular and close spaced set of conjugate joints cut the sandstone in places, producing a collumnar appearance.

There were three phases of post Jurassic igneous activity in this area.

The first phase was the intrusion of a series of basic sills in the sandstone. These vary in thickness reaching a maximum of about thirty feet. A thick sill which crosses the Harrar road to the south of Dira Dawa contains many large vesicles, filled by agate and quartz, calcite and fibrous zeolites.

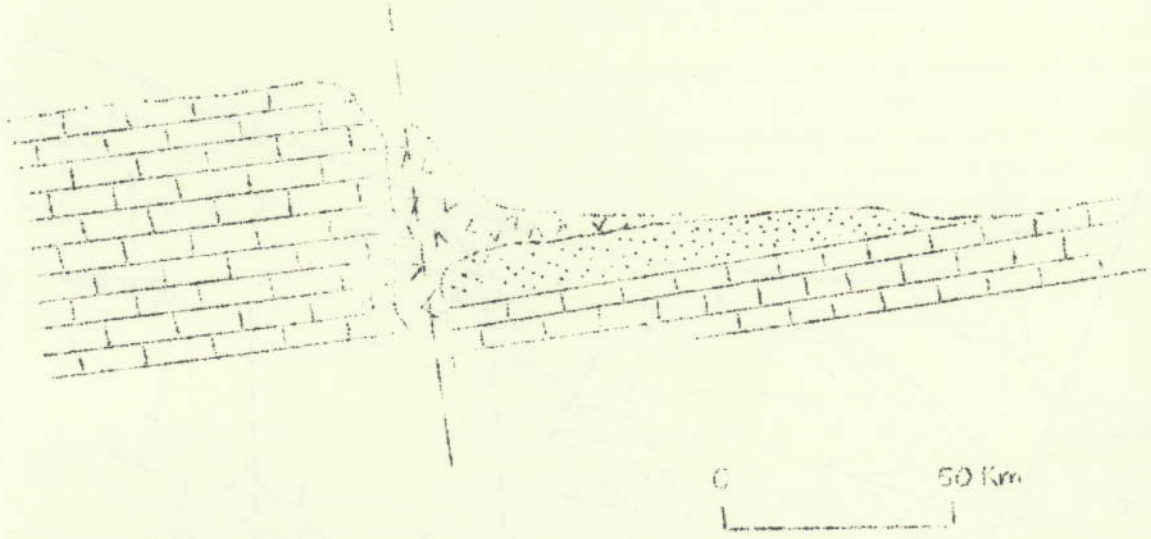
A set of fault controlled dykes also occur in this area. These reach a maximum thickness of 50 ft. They are basic and mostly fine grained. These are well developed in the Precambrian along the Harrar road where many are oriented east-west and are probably controlled by the rift fault system.

The basic sills are cut by intrusions of a much larger scale, of a fine grained, white coloured rock. The largest of these occupies an area of about two square miles to the south of Dira Dawa. Six similar but smaller intrusions were mapped to the west.

The main intrusion is almost entirely in sandstone, and is elongated parallel with the strike of the country rocks. Contacts with the sediments that the intrusion is in the form of a thick sill. The sediments have been pushed aside, with considerable deflection of strike.

The other smaller intrusions of similar rock type also have a sill-like form, contacts with the country rocks are usually conformable and

Possible form of the smaller intrusions

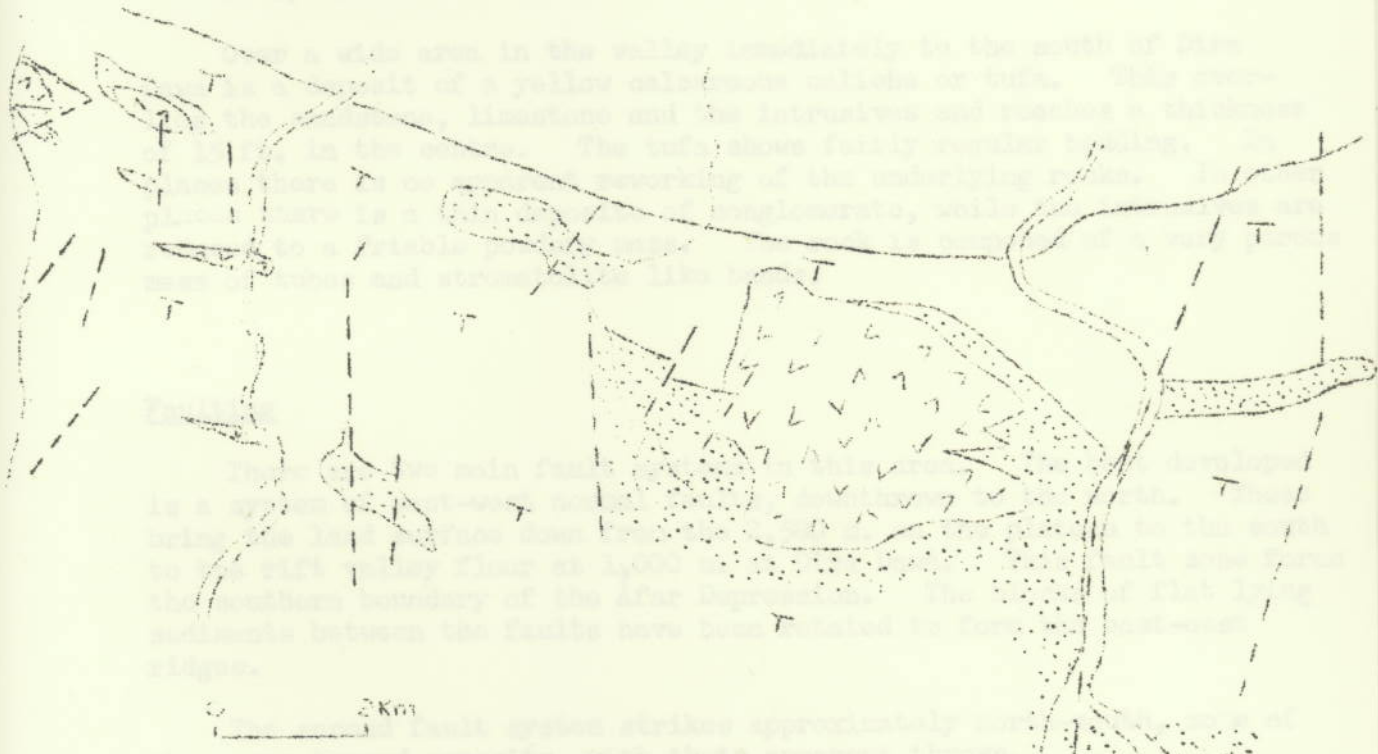


INTRUSIVES

SANDSTONE

LIMESTONE

THE NORTH - SOUTH FAULT SYSTEM



T LIMESTONE (ALSO STRIKE)

SANDSTONE

INTRUSIVE

steeply dipping. Some may, however, be associated with the east-west faults, for in places the intrusive is plastered along the fault line scarp of the limestone.

Contact metamorphism of the sediments is mostly slight. The limestones commonly have a few feet of re-crystallised flinty rock. Skarns are not developed. The sandstones are re-crystallised to a white quartzite.

All the igneous rocks of this area are very deeply weathered. Spheroidal weathering is particularly well developed in the white coloured intrusives. The depth and extent of weathering makes the collection of specimens for thin section study very difficult.

Over a wide area in the valley immediately to the south of Dira Dawa is a deposit of a yellow calcareous caliche or tufa. This overlies the sandstone, limestone and the intrusives and reaches a thickness of 15 ft. in the centre. The tufa shows fairly regular bedding. In places there is no apparent reworking of the underlying rocks. In other places there is a thin deposite of conglomerate, while the intrusives are reduced to a friable powdery mass. The rock is composed of a very porous mass of tubes and stromatolite like bands.

Faulting

There are two main fault systems in this area. The best developed is a system of east-west normal faults, downthrown to the north. These bring the land surface down from the 2,500 m. on the plateau to the south to the rift valley floor at 1,000 m. at Dira Dawa. This fault zone forms the southern boundary of the Afar Depression. The blocks of flat lying sediments between the faults have been rotated to form the east-west ridges.

The second fault system strikes approximately north-south, some of these are traced opposite, with their apparent throws.

Economics

There is little of economical interest in the geology of this area.

There is a small quarry in the limestone to the south of the town of Dira Dawa which supplies a cement factory. Limestone is also collected from the ridges to the south of the town and laboriously broken up for road and railway maintainance.

The main intrusion to the south of the town is quarried for building stone.

Small amounts of galena have been found by local villagers to the west of Dira Dawa. The mineral occurs in a dense white quartzite, but

the exact location of the scource has never been located.

The iron concentrations in the sandstones have no economic significance.

Conclusion

This is only a brief summary of the giology of the area mapped and a preliminary map is included, prepared by direct tracing from aereal photographs. Some distortion is inevitable in the map because of its compilation directly from photographs.

PART III

A NON-TECHNICAL REPORT

OF THE

GEOLOGICAL MAPPING PARTY

- by -

T. MARPLES

ETHIOPIA '67

The expedition was planned in October 1966, and received the approval, and later a grant, from the Imperial College Exploration Board. We bought a landrover from the '66 Bolivia Expedition and then started the work of writing to firms all over the country for financial backing. By Easter 1967 we had almost reached our target total. We had booked our passages, with Messzgerie Maritimes, for travel from Marseilles to Djibouti. Then in the early summer, disaster struck. The UAR/Israeli war started so we were no longer able to use the Suez Canal. This blow was somewhat offset by the news that we had been awarded the De-Havilland Award. We could now afford to fly ourselves direct to Addis Ababa. Unfortunately, our landrover, which I had so carefully stripped, repaired, assembled, and prepared, was now useless as the cost of transporting it to Ethiopia proved to be prohibative. However, we did learn from one of our contacts in Ethiopia - Mr. Levin Djerahan, a student of Imperial College - that landrovers could be hired in Ethiopia for a reasonable amount. Now nothing stood in our way, we had excellent contacts in the Geological Department of Haile Selassie I University in Addis Ababa, and our equipment was ready.

At 9.15 a.m. on Saturday 15th July the five of us were walking across the tarmac at London Heathrow to board an Alitalia Boeing 707. This was the last time we would see England for two months.

Our flight to Rome was uneventful, apart from a glimpse of the Alps through their covering of cloud. We arrived at Rome at midday, with thirty-six hours to spend exploring, before our flight out to Addis Ababa. What an average tourist sees in one week we saw in two days.

Our midnight flight on Sunday left on time. We stopped in Athens for 40 minutes, and then slept until breakfast at 5 o'clock. One hour later we were stretching our legs on the tarmac at Khartoum airport. We arrived in Addis Ababa at 8 o'clock in the morning, local time. The elevation being 8,200 ft. we expected some sort of breathless effect, but there was none.

On the plane we had made friends with Miss Jean Riley, who was returning home from her school in England. Her father, who works for the UN. in Addis Ababa, met her at the airport, offered us a lift into Addis Ababa, and very kindly offered to find us a cheap hotel. This took the form of an Italian Style Pension, run by an Israeli lady known affectionately to all and sundry as 'Mama'. She made us very welcome and we were soon set up with three rooms in a chalet. The food was exclusively Italian, which was typical of most restaurants in the larger towns of Ethiopia.

Many of the Italians who invaded the country during the war returned with their families and built roads, shops, schools, etc., and settled down. Their influence is to be seen all over Ethiopia, but especially in the North.

On Monday afternoon all of us went to the University to see Dr. Gibson, our main contact in the Geology Department. Dr. Gibson studied at Imperial College as an undergraduate and postgraduate and visits there periodically. It was as if we were going to meet an old friend. We found him, or rather

he found us, and he was amazed to see us, having assumed that with the war blocking Suez we would not be coming. However, he soon recovered sufficiently to give us details of what he had previously planned. Permission had to be obtained from the Ministry of Mines before we could buy aerial photographs. John, our geologist, at once set off to find it. Dr. Gibson then suggested that Chris St.John and I should accompany him on a small field trip he had planned to Mt. Chabbi, a very interesting volcano. Chris and I accepted and when John returned he was not happy. The Minister, who could give us permission, was in Russia, and would not return for a few days. John decided to go to the Highways Authority, to find which aerial photographs he required; then when the Minister returned he would be able to ask permission to (a) map the area Dr. Gibson had assigned to us, and (b) buy the aerial photographs.

Meanwhile Chris and I set off with Dr. Gibson and one of his third year students, Makonnen, to go to Awassa. We left Addis at 10.30 a.m. on Tuesday morning and drove in pouring rain as far as Modjo, before stopping for lunch. We then journeyed on to Abieth, where we made a slight detour to see a salt water lake. Flamingoes, pelicans, and maribou storks were abundant, as were the dead fish which had died due to an increase in the salinity of the water. We arrived at Awassa at 6 o'clock and pitched our tent in the grounds of a hotel. For the next two days we studied the volcano known as Mt. Chabbi.

The first day was spoilt by low cloud and a torrential downpour in the afternoon. However, the second day proved more fruitful. We revisited the steam vents on 'Hot Cone', and also found what we had come to see - tension fissures and fumaroles. One of the larger fumaroles was inhabited by bluey-yellow bats. How they existed in such a sweltering hot, steamy atmosphere I don't know. Chris rolled a boulder down one of the larger tension fissures and it resounded against the sides for many seconds.

On the way back from the crater Dr. Gibson noticed that a number of peaks in the distance formed what he thought was a giant caldera. He assured us that if it was not named on the maps he would name it Imporial Caldera in honour of our mutual College.

We now returned to Addis Ababa via Lake Langano, a holiday resort popular with the wealthy Ethiopians and Europians. On arrival back in Addis Ababa we found John waiting for us and after several plans had been put forward we decided that all three of us should go to Dire Dawa on the night train, and then John would return to Addis Ababa to collect the photographs when they were ready.

The train journey took twelve hours and was probably the worst I have ever been on. The third class trucks had benches down the side and as the journey progressed more and more people crammed into our truck. The smell was so overwhelming that we had to lean out of the windows for the last part of the journey.

At Dire Dawa it was hot even at 8 o'clock in the morning. We hired a taxi to take us to Alemaya College where, we were assured by Dr. Gibson, we would find an American peace corps worker, Charles Ipcar, who would be pleased to assist us in any way. At Alemaya College, some 30 miles away, we were

informed that they new of no one by the name of Charles Ipcar. So back to Dire Dawa. After a rather tiring argument with the taxi driver, we paid him nearer his price than our offer. We now looked up another contact, Mr. Garber was an American Mennenite missionary. We found the mission and his house-boy, Briani, but no Mr. Garber. Briani gave us some food and introduced us to some of his friends. Mr. Garber had evidently gone on a trip and would not be returning until late in the afternoon. We walked around Dire Dawa, finding it was very hot, in the low hundreds I would say. When Mr. Garber returned we found him most amiable. He invited us to pitch our tent in his grounds until we found out just where we were. We at last had a base. We slept well that night. The next day, with the help of Briani, we bought food and cooking equipment. We went up to the local High School, where, according to Mr. Garber, we would find Charles Ipcar. As usual, "he wasn't there, but would be returning soon". Eventurally, he did and John gave him the low-down on our mission. He O.K.'d it and loaned us some equipment. The next day John, Chris, and I went to look over our area. It was not a pleasant sight - mountainous, scrubby, weathered semi-desert.

That evening John went back to Addis Ababa to collect the photographs. Chris and I now had a few days to spare. We went to Harrar, the province town, (acting somewhat like a county town in England), and saw the local market and basket work, some of it brightly coloured. It was not healthy at all and by midday we returned.

Dire Dawa is a pleasant town much cleaner and tidier than Addis Ababa. In Addis Ababa there were lepers and cripples begging in the streets. There were hardly any pavements, just mud paths. In Dire Dawa the streets were swept and the tree trunks painted once a day - at least we assume it was once a day because throughout the whole of our stay there, there was always sweeping and tree painting.

As is the custom in Mediterranean countries, there was a siesta from 12 to 3 - the hottest part of the day.

Chris and I re-pitched the tent slightly and tidied around. John returned on Sunday, and on Monday morning at 5.30 a.m. we started mapping.

Two hours later we were arrested.

We were quietly working on a limestone escarpment when we were surrounded by ragged looking soldiers, holding guns. This motley crew decided to take us to their local headquarters in Dire Dawa. Here we were mildly interrogated, then driven to the divisional headquarters in Harrar. Here we met a captain who, speaking better English than his subordinates, freed us after an inspection of ourselves and our motives for mapping. We returned home, cooked a meal and went to bed.

The following day I remained in camp while John and Chris went off bright and early again at 5.30. At 9.30 I was dragged in for questioning, this time by an immigration and national security chief. Two hours later, after fairly extensive questioning and confiscation of passports and identity cards, I was released and told to find John and Chris within three hours. In the midday heat I had to search forty-odd square miles for two fellow Englishmen.

I had a rough idea where they had gone. After about two hours they found me, revived me with water, as they had taken all the flasks, and I gasped out my story. Back we went.

This time all our equipment and our precious aerial photographs were taken away, but we insisted on the return of our passports and I.D. cards. House, or rather tent arrest isn't all that funny. However, it wasn't to last for long. Twenty four hours later we were back in the security chief's office. This time it was different. No banging of desks, but smiles; no shouting, but cokes all round. There had been a terrible mistake. It was known that Somali terrorists were in the area and that white mercenaries had been hired to kill Haile Selassie when he came to Dire Dawa, and after a telephone call to the Ministry of Mines in Addis Ababa it was clear that we were important people working for the government. From that day on we had the fullest possible co-operation from both police and the army.

Now we could start mapping.

Dire Dawa lies 300 miles roughly south-east of Addis Ababa and is the last major railway station before the train crosses into French Somalia. Hence, it goes without saying that smuggling was rife. We were offered everything from radios and watches, to cigarettes and lighters. I bought some of the contraband cigarettes, although it was dangerous to do so. Back street bargaining can be quite fun, especially when both parties are keeping a look-out for the law.

Dire Dawa is splet by a big dried river bed and the two quarters are like oil and water - the Somali Arabs live on the east and the Coptic Christians live on the west. An American peace corps worker had accidentally wandered into the Somali quarter and was almost beaten to death. This happened only a fortnight before we arrived. Incidents only occur after nightfall so we were safe when going to the bus station and to buy goodw.

A typical day's mapping would be: awake at 5 a.m., finish breakfast of scrambled eggs and coffee by 5.45 a.m., set off walking at 6 a.m. How long we spent walking depended on the distance to the mapping area for that particular day. First one hour, then two, and in the last few days three hours were spent walking before we could start work. On arrival at Addis Ababa we had found that landrovers were not available for hire in Dire Dawa, and it would have proved too expensive to run it down to Dire Dawa from Addis Ababa, so we walked everywhere. The day's mapping ended at 1.30 p.m. - 2.30 p.m., depending on how unbearable the heat was. On arriving back at the tent I cooked an evening meal while John wrote up his day's findings. Chris tidied around and did washing etc.

We had our fair share of ailments: John and I caught dysentery rather badly, but on our second night of suffering on of Mr. Garbers friends had seen our plight and plied us with paragoric which killed the pain. He also prescribed triple sulphur as a cure for chronic diarrhoea. We called the triple sulphur "quick setting cement" because that was its effect. However, no major diseases befell us. I caught a cold. John fell down and scored his knee rather badly, and Chris had a touch of gastric trouble.

Mr. Garber was always a help. His wife would occasionally invite us

to dinner or to ice-cream oarties which we thoroughly enjoyed. He gave us permission, and actually was delighted when we asked if he minded us staying in his compound, although I suppose three lily-white explorers disappearing into the hills at unearthly hours of the morning and rrturning mid-afternoon thoroughly exhausted, with sweat-salt caked on their faces, was not exactly a pleasant sight every day. This went on for three weeks, then the Aeronautical people had got around to Dire Dawa so we had a reunion.

I was now to go to Assab instead of one of their members who had a sun allergy. I soon found out why. When we arrived at Assab I just couldn't believe it could get so hot. It was similar to holding a hair-dryer directly in front of ones face. The wind was scorchingly hot. We surveyed the airfield the same day, and had to wait another day before flying bqck to Dire Dawa. Here we were hit by luck again - while we were drinking our iced soda-water in a hotel courtyard, some Europians entered. They recognised us, and, instants later we recognised them - they were the two lecturers in Geology from the University of Addis Ababa with some friends. These were introduced as two Leeds postgraduates who were doing similar work to ourselves, on a larger scale, in the southern region of Ethiopia. We all talked well into the early hours of the morning, and on the following day we flew back to Dire Dawa.

The mapping continued and Joyn, our geologist, was much the worse for wear. Finally after five weeks non-stop mapping, (apart from two days when it rained), John decided to rest for two days. As Chris was now wanted on the Aeronautical project, John and I were left to face the last two weeks. We mapped some of the exposures in cuttings on the road to Harrar, 15 miles, and then put the finishing touches to the map. We finally broke camp, thanked Mr. and Mrs. Garber, and left on the morning train.

During our last week John and I had indulged ourselves once or twice by going into the Ras Hotel swimming pool for the afternoon, after our morning's work. This was absolute ecstasy. We also had a day trip to Harrar to see the old city wall and to buy baskets, spears, etc.

Charles Ipcar had left the area a fortnight previously and had been quite helpful. He once took us to the zoo at the Alemaya College of Agriculture, and it was here that we met the only friendly hyenas.

Every day without fail we would see wild hyenas or baboons. One or two chased John, but no harm was done.

The local beast of burden was the camel, and the locals used them for everything - milk, meat etc., and their dung for fuel.

The local Ethiopians we met were exceedingly friendly on the whole. There were two exceptions, but this hostility was, no doubt, due to the invasion of their privacy. Firstly an old man chased us away from his village shouting so loudly that the echoes in the mountains took many seconds to die away. The second didn't want his photograph taken and was prepared to break the camera if we insisted. The rest were friendly, the girls shy at first of having their photographs taken, but persuasion and a little money soon cured this.

In the villages the people lived in wattle and daub huts which stood up to the rain quite well, and only needed repairing once a year after the rainy season. The food eaten by the locals was 'wot' and 'njera'. Njera is a sort of unleavened bread, about 2-3 ft. in diameter. Wot is a stew which was served placed in the middle of the njera. One eats by breaking lumps of the njera with the hands, wrapping it around the meat and eating it with the fingers. This was the only food we ever saw them eating, and we were informed this was the staple diet of 90% of Ethiopians - the poor Ethiopians.

Ethiopia is very high - e.g. Addis Ababa is at 8,200 ft., and Dire Dawa is at 3,000 ft. During our last week John and I attempted to climb Mt. Kulubi, 11,000 ft., but at 10,500 ft., we turned back because of tiredness and also low clouds were forming. At Kulubi there is a beautiful Coptic church which John and I entered, and were shown round by the priest. Several of the ornaments and tapestries were presented by the Russian Orthodox church and the Czechoslovakian church.

When John and I arrived back in Addis Ababa we stayed at the YMCA while waiting for our plane. We took the opportunity of resting, and washing and having a shower every day, which by now was a luxury. We visited the large market in Addis Ababa called the 'Makato' where we again bought souvenirs.

Saturday 9th September was a day we had all been longing for - day we were going home. But fate had her final fling. Our plane - a U.A.A. comet was flown not to Cairo as we expected, but to Nairobi, across the equator, to pick up some Pakestan and Indian families who were being evacuated out of Kenya because of political troubles. So when we finally arrived in Cairo we had missed our connection to Paris. However, after a lot of argument with officials we finally boarded a duplicate which was laid on for all the Pakistanis and Indians. Paris looked wonderful from the air, but it was London we wanted. Soon, after a trip in a BEA trident we had our dream come true - we were back in the good, old U.K., after two months of hazardous life. In retrospect, it was fun, but when talking about my experiences, and laughing off illness, sickness, misery and depression, I shall always know deep in my heart that this was no joy ride, it was hell at times, and if it hadn't been for one or two strokes of good fortune, our story might have been different.

One afternoon, when we were at a very low ebb in the tent, Briani brought a radio into the tent. He had borrowed it for us, and we could have it for a couple of hours. Naturally we were glued to it during two hours of BBC world service programmes and the news. Yorkshire had once again retained the county championship, and Sheffield Wednesday were on top of Division One. Coming from Sheffield, being a Yorkshire man, and a fanatic Wednesday supporter I was cock-a-hoop. The other two cheered up tremendously as well and I'm sure it kept us going. In Addis Ababa we were given lunch by the secretary to the Ambassador and it was wonderful - really kindled the life in us: sherry, soup, fish, chipped potatoes, vegetables, sweet, cheese and biscuits, followed by brandy and liqueurs. It was marvellous and we appreciated it very much, it raised us from the depths.

In the last few paragraphs I would like to thank Mr. Levin Djerahan for his help, assistance, and friendship; also his parents, relations and friends who made us feel at home on our return to Addis Ababa. Also Levin

accompanied the Aeronautical people, assisting them in their project on the airfields.

Lastly, was our geological map a success? Yes, undoubtedly. Considering our circumstances we had done exceptionally well. In the University of Addis Ababa the head of the Geology Department congratulated us on 'a precise and accurate map'.

I would like to say in conclusion, that if any budding explorers are reading this and are fired to go exploring, one piece of advice: there is only one piece of equipment you really need, without it we would have been lost time and time again, and this is 'the will to survive'.
