Ministry of Water & Energy（MoWE）
The Federal Democratic Republic of Ethiopia
Somali Regional Water Resources Development Bureau

THE STUDY ON JARAR VALLEY AND SHEBELE SUB-BASIN WATER SUPPLY DEVELOPMENT PLAN, AND EMERGENCY WATER SUPPLY IN THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

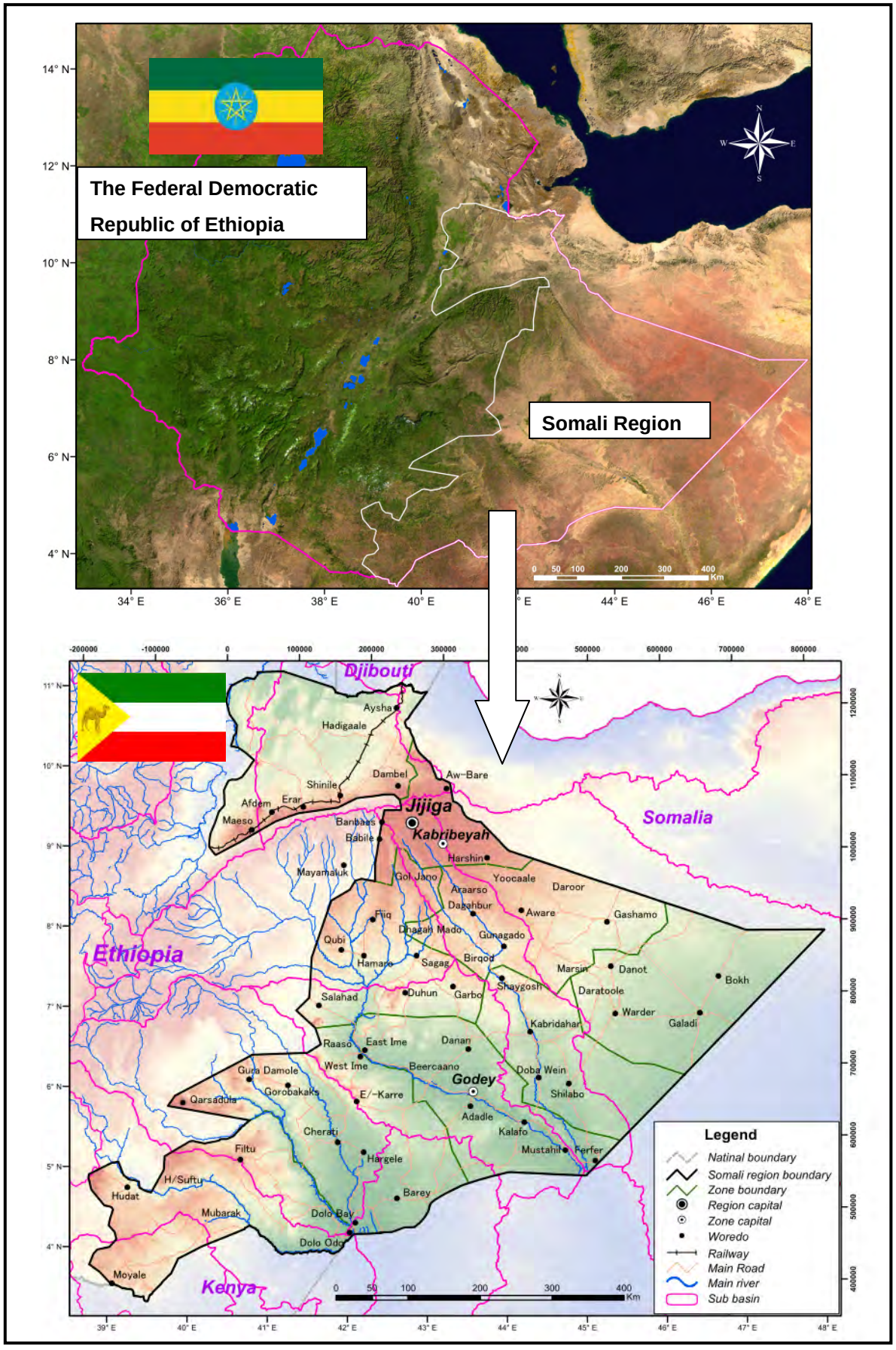
FINAL REPORT

DATA BOOK

August 2013

Japan International Cooperation Agency（JICA）

Kokusai Kogyo Co., Ltd.



Location Map of Study Area

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Volume.1

1. Meteorology and Hydrology

1. Meteorology and Hydrology

Data 1.1.1 Hydrometric Station Installed in the Wabi Shebele River Basin

Annex I: Hydrometric stations installed in the Wabi Shebelle River Basin.

Station Code	WS No.	River	Town near by	Cordinates Lat. (North) deg -min	Lon. (East) deg -min	Altitude (masl)	year of Install. m/d/y	Watershed area (MWR) km²	Watershed area (Current Project) km²	Installed instruments Staff gaug.	Rec.	BOC	Station status
Western Upper Course													
61004	H1	Wabi	@Bridge	***7 - 01***	***39 - 02***	***2500***	1967/1/30	1035	1040	*		*	Operational
61009	H2	Wabi	@Melkawakana	7 - 11	39 - 26	2485	1967/7/22	4388	4452	*	*	*	Dammed in 1984
61003	H3	Ukuma	Nr. Dodloa	***7 - 00***	***39 - 03***	***2450***	1967/1/25	137	137	*			Operational
61016	H4	Fruna	Nr. Adaba	***7 - 01***	***39 - 25***	***2405***	1989/4/5	8	86	*			Operational
61005	H5	Assassa	Nr. Assassa	***7 - 06***	***39 - 12***	***2360***	1967/2/25	68	142	*			Operational
61012	H6	Robe	Nr. Robe	***7 - 51***	***39 - 38***	***2355***	1969/3/8	175	169	*		*	Operational
61014	H7	Herero	@ Herero	***7 - 00***	***39 - 12***	***2355***	1967/1/24	133	122	*			Operational
61006	H8	Wolkessa	Nr. Azazera Kerey	7 - 50	39 - 33	2350	1967/3/8	27	31	*			Not Operational
61010	H9	Maribo	Nr. Confluence	7 - 06	39 - 22	2350	1968/1/1	1039	1008	*			Overflooded by the Melka Wakana Dam
61015	H10	Maribo	Nr. Kara Birole	6 - 57	39 - 22	2350	1967/7/5	200	179	*	*	*	Operational
61001	H11	Lelisso	Nr. Adaba	***7 - 00***	***39 - 23***	***2345***	1967/1/10	135	120	*		*	Operational
61002	H12	Maribo	Nr. Adaba	***7 - 00***	***39 - 20***	***2330***	1967/1/24	185	192	*	*	*	Operational
61007	H13	Ululu	Nr. Azazera Kerey	7 - 50	39 - 33	2300	1967/3/9	21	27	*			Not Operational
61008	H14	Harerghe	Nr. Assa Osman	7 - 46	39 - 33	2100	1967/6/25	41	59	*			Operational
61013	H15	Wabi	@ Hako	7 - 13	39 - 27	2100	1972/5/2	4581	4540	*	*		Release from the Melka Wakana dam
Eastern Upper Course													
62009	H16	Hirna	Nr. Hirna	9 - 13	41 - 06	2100	1980/12/2	25	40	*			Operational
	H17	Galeti	Nr. Hirna	9 - 07	41 - 08	1400			523				Is being installed
62006	H18	Lake Adele	@ Adele	***9 - 25***	***41 - 56***	***2000***	1980/5/25	48	24	*			Operational
62010	H19	Dawe	Nr. Gara Muleta	9 - 20	41 - 48	2000	1981/2/12	344	29	*		*	Operational
62005	H20	L. Alamaya	@ Alamaya	9 - 24	42 - 01	1900	1975/3/27	50		*			Operational
62007	H21	Hamaressa	Nr. Harar	9 - 20	42 - 05	1900	2008/11/26	56	29	*	*	*	Operational
62015	H22	Jawes	Nr. Bedesa	8 - 55	40 -47	1800	1984/1/18	22	21	*			Operational
62018	H23	Kella	Nr. Bedesa	8 - 54	40 - 46	1800	1987/5/27	12	11	*			Operational
62019	H24	Kollu	Nr. Bedesa	8 - 54	40 - 47	1800	1987/5/27	21	21	*			Operational
	H25	Medhido	Nr. Bedessa	8 - 50	40 - 44	1680							New station
62012	H26	Upper Dac.	@ Dacata Bridge	9 - 12	42 - 25	1350	1983/2/3	312	312	*	*	*	Not Operational
62008	H27	Bissidimo	@ Bissidimo	***9 - 13***	***42 - 12***	***1340***	2008/11/25	147		*			Operational
62013	H28	Upper Erer	Nr. Babile	***9 - 14***	***42 -15***	***1400***		469	494	*		*	Operational
Middle Course													
61011	H29	Wabi	@Legehida	7 - 58	40 - 54	950	1968/4/4	20473	**19793**	*	*	*	Abandoned due to their in accessibility
62004	H30	Sulul	Nr. Segag	7 - 39	42 - 50	800	1972/6/23	3589	2314	*			Abondoned
62001	H31	Dacata	Nr. Hamaro	7 - 20	42 - 17	500	1968/2/5	15188	15262	*	*		Abondoned
62002	H32	Wabi	Nr. Hamaro	7 - 24	42 - 11	470	1968/2/11	63644	63242	*	*	*	Abondoned
62003	H33	Erer	Nr. Hamaro	7 -37	42 - 02	450	1968/5/23	15132	14760	*	*	*	Abondoned

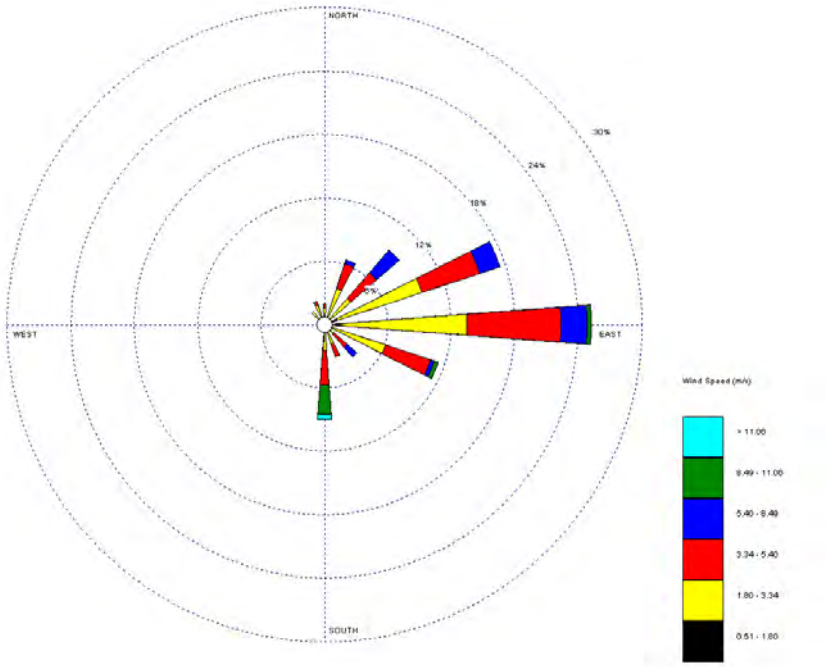
Station Code	WS No.	River	Town near by	Cordinates Lat. (North) deg -min	Lon. (East) deg -min	Altitude (masl)	years of Installation m/d/y	Watershed area km^2	Watershed *area (Current Project)* km^2	Installed instruments Staff gaug.	Rec.	BOC	Station status
Lower Course													
63006	H34	Wabi	@ Imi	6 - 29	42 - 08	405	1969/3/1	91600	90918	*	*		Is being rehabilitated
63008	H35	Wabi	@ Buliche	6 - 26	42 - 13	360	1974/12/4		**109488**	*			Abandoned
63012	H36	Wabi	At Dam Site			298	1986/4/21			*	*	*	Operational
63001	H37	Wabi	@ Gode	5 - 56	43 - 33	285	1967/10/4	127300		*	*		Relocated
63002	H38	Wabi	@ Gode Bridge	5 - 53	43 - 34	284	1977/2/26	127300	124108	*	*	*	Operational
63011	H39	Wabi	Below Dam site	6 - 00	43 - 09	280	1986/2/24			*	*	*	Operational
63010	H40	Wabi	@ Kelafo	5 - 36	44 - 08	249	1969/1/8	139100	134334	*			Abondoned
63009	H41	Wabi	@ Mustahil	5 -14	44 - 43	248	1977/2/5		146386	*	*		Abondoned
63005	H42	Wabi	@ Burkur	5 - 11	44 - 48	247	1969/1/6	144000	**146804**	*	*		Abondoned
		Wabi	Nr Tubis	6 - 57	42 - 08	500			88105				
The closed watershed of Fafen (46 414 km2)													
Upper course													
	H43	Toga	@ Jijiga	9 - 21	42 - 48	1700			344				
62016	H44	Jijiga	@ Jijiga	9 - 21	42 - 48	1700	1985/3/11	947	731	*	*	*	Operational
62014	H45	Upp. Fafam	@ Bridge	***9 - 14***	***42 - 36***	***1520***	1983/6/19	900	910	*			Operational
62013	H45	Upper Jerer	@ Jerer	9 - 14	42 - 15	1450	1983/2/4	469	386	*			Operational
Middle course													
63003	H46	Jerer	Nr. Degehabour	8 - 13	43 - 33	1050	1967/10/9	6338	5246	*	*	*	Not Operational
Lower course													
63004	H47	Fafen	@ Kebridehar	6 - 45	44 - 17	525	1968/6/28	26670	**24956**	*	*	*	Not Operational
The closed watershed of Bio Adi (8 387 km2)													

* provided by MoWE

Data 1.1.2 Wind Rose diagram of Gode (1/6)

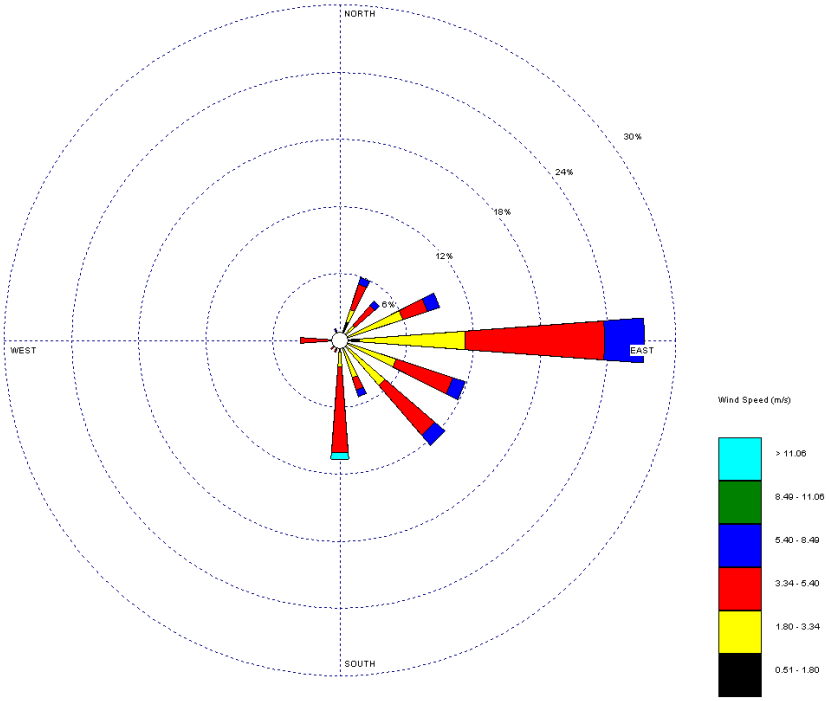
1. Wind-rose diagram of Gode for the month of January

Based on 1966-2002 data at 1200 GMT



2. Wind-rose diagram of Gode for the month of February

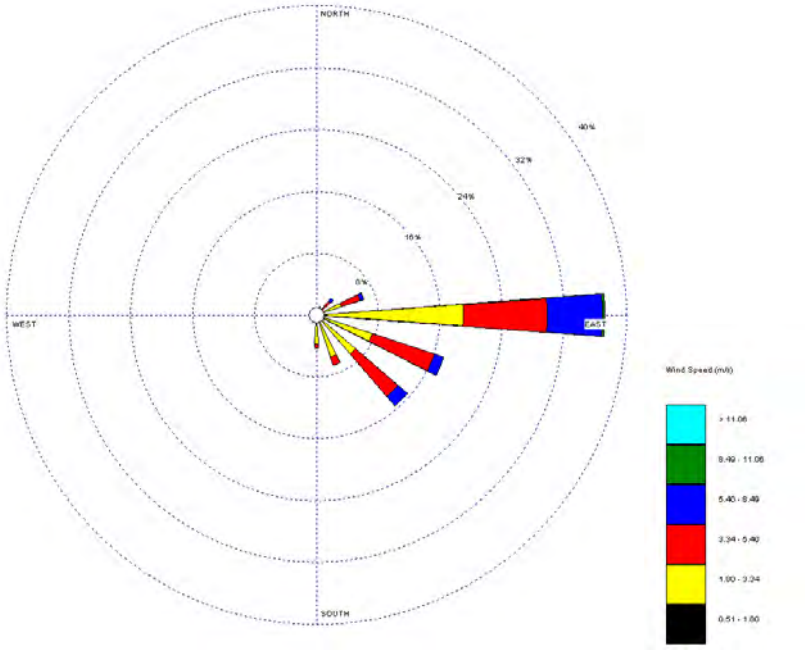
Based on 1966-2002 data at 1200 GMT



Data 1.1.2 Wind Rose diagram of Gode (2/6)

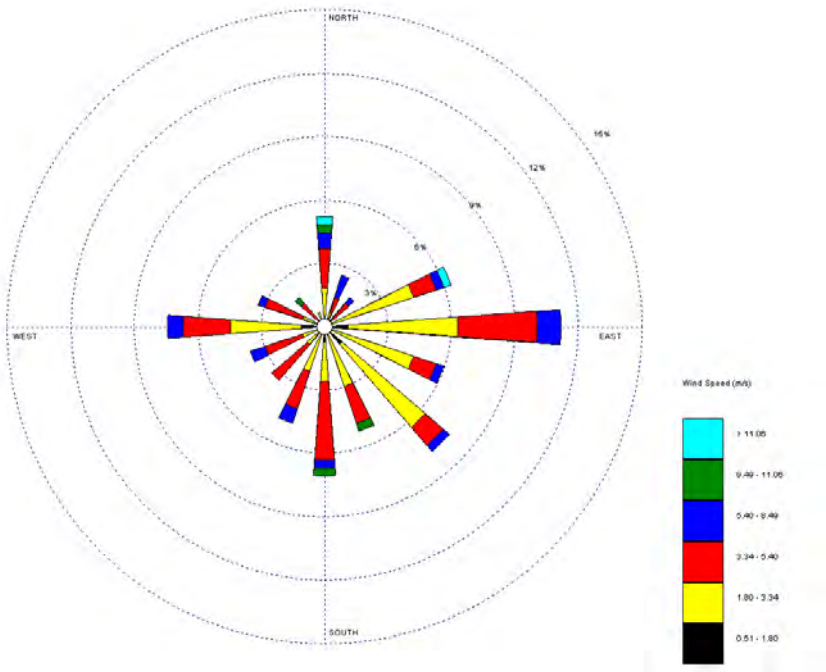
3. Wind-rose diagram of Gode for the month of March

Based on 1966-2002 data at 1500 GMT



4. Wind-rose diagram of Gode for the month of April

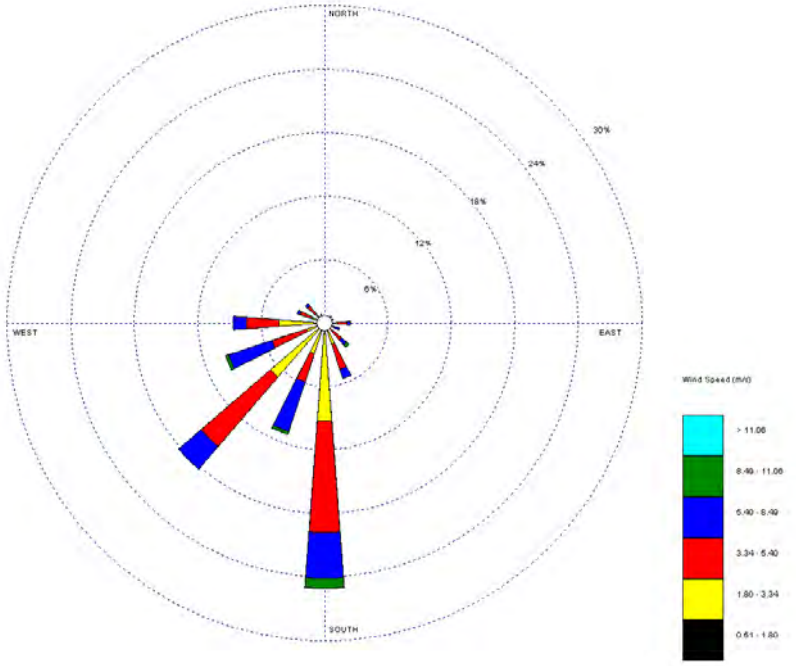
Based on 1966-2002 data at 1200 GMT



Data 1.1.2 Wind Rose diagram of Gode (3/6)

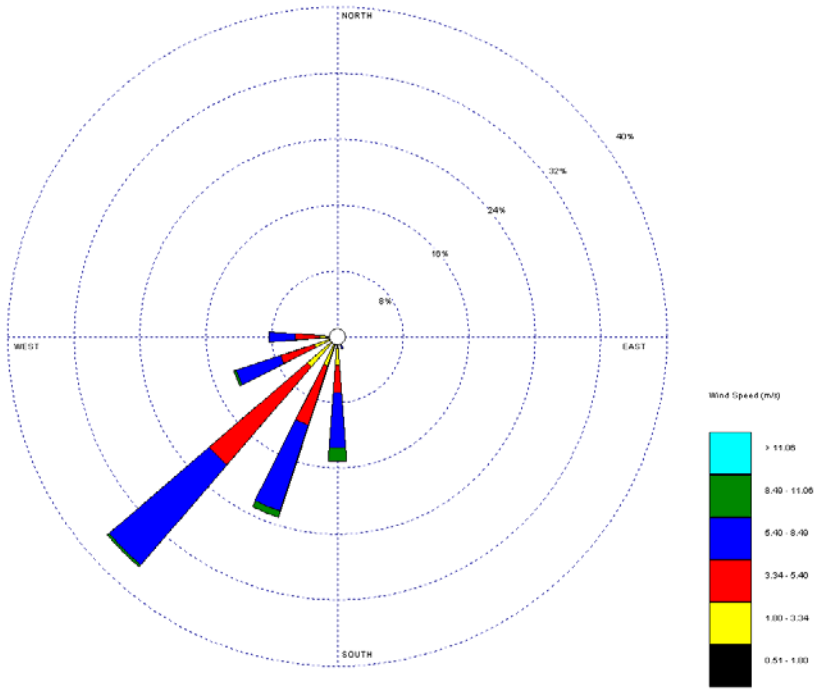
5. Wind-rose diagram of Gode for the month of May

Based on 1966-2002 data at 1500 GMT



6. Wind-rose diagram of Gode for the month of June

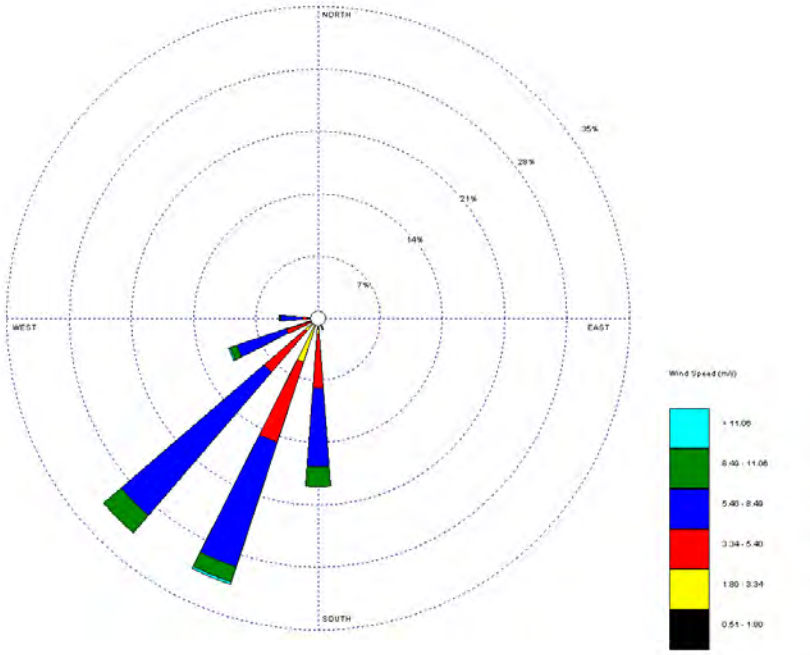
Based on 1966-2002 data at 1500 GMT



Data 1.1.2 Wind Rose diagram of Gode (4/6)

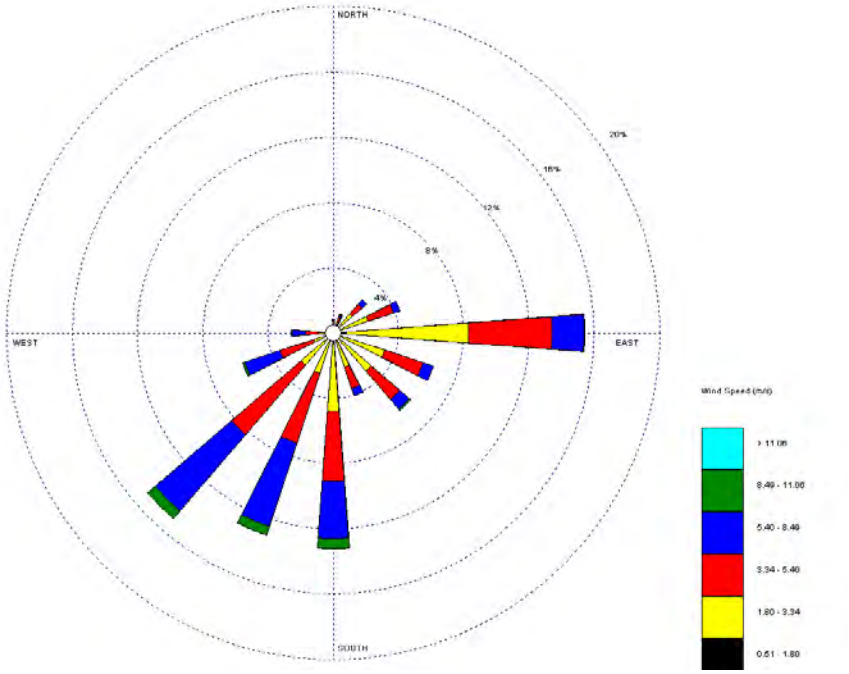
7. Wind-rose diagram of Gode for the month of July

Based on 1966-2002 data at 1500 GMT



8. Wind-rose diagram of Gode for the month of August

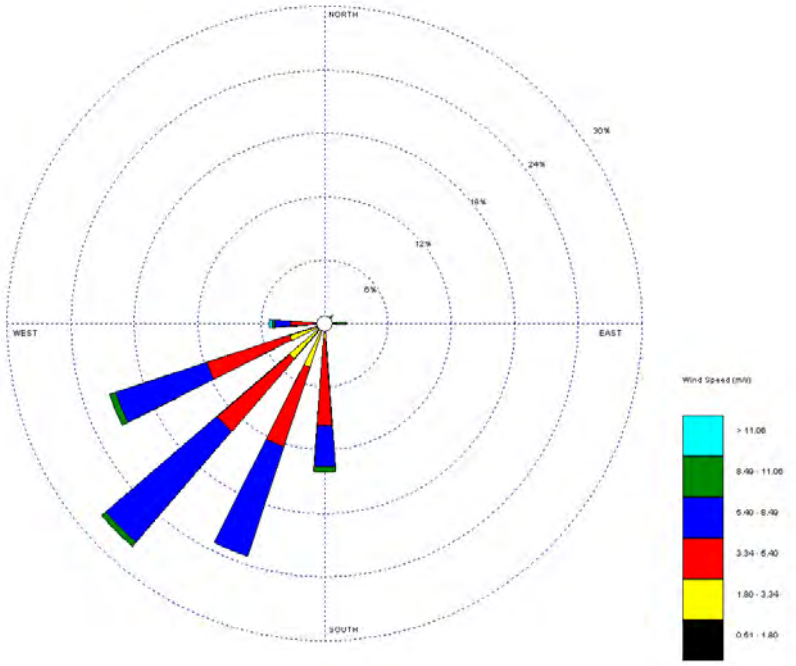
Based on 1966-2002 data at 1500 GMT



Data 1.1.2 Wind Rose diagram of Gode (5/6)

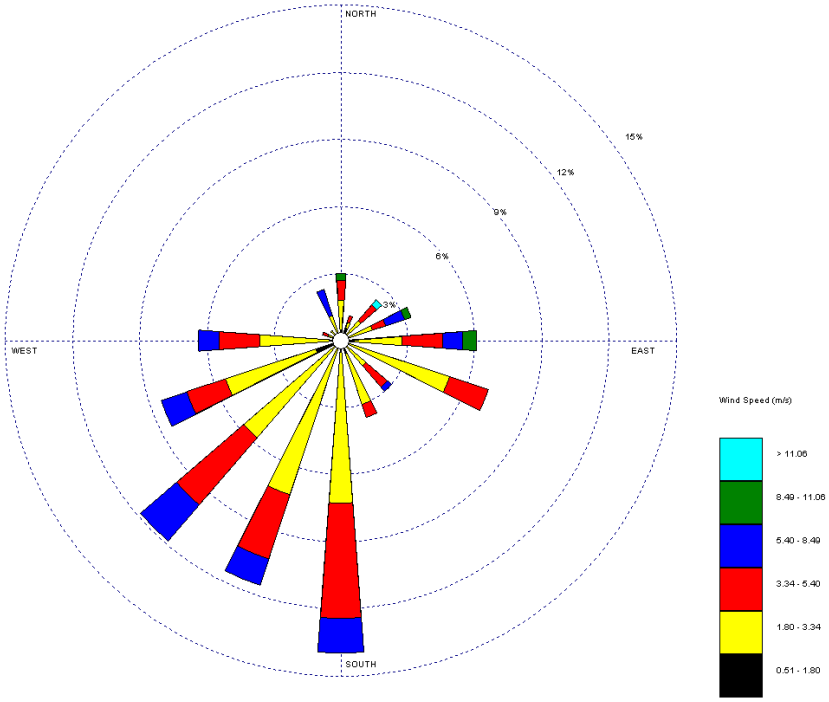
9. Wind-rose diagram of Gode for the month of September

Based on 1966-2002 data at 1200 GMT



10. Wind-rose diagram of Gode for the month of October

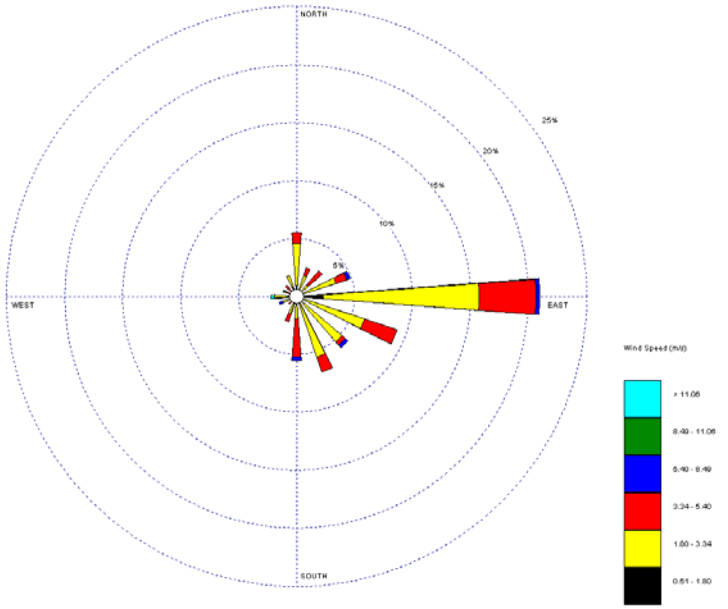
Based on 1966-2002 data at 1200 GMT



Data 1.1.2 Wind Rose diagram of Gode (6/6)

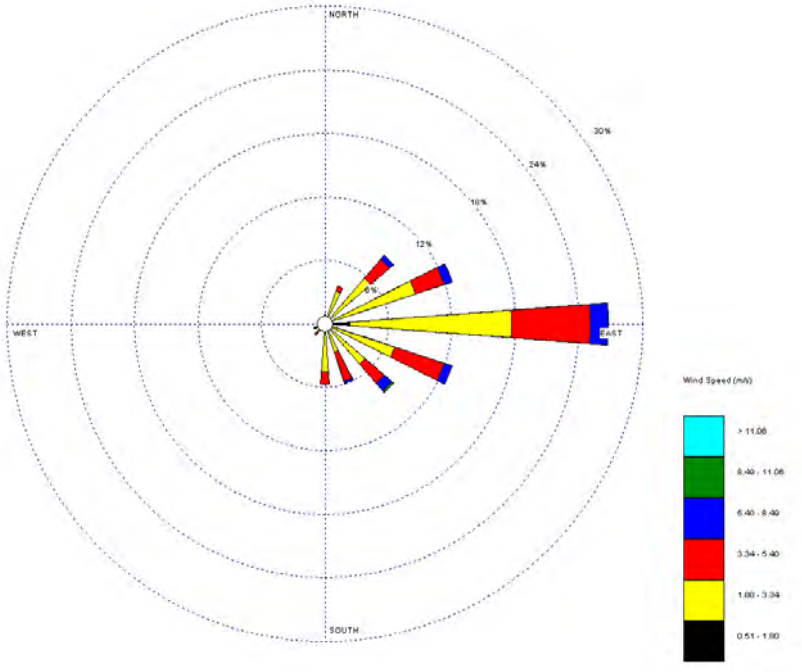
11. Wind-rose diagram of Gode for the month of November

Based on 1966-2002 data at 1200 GMT



12. Wind-rose diagram of Gode for the month of December

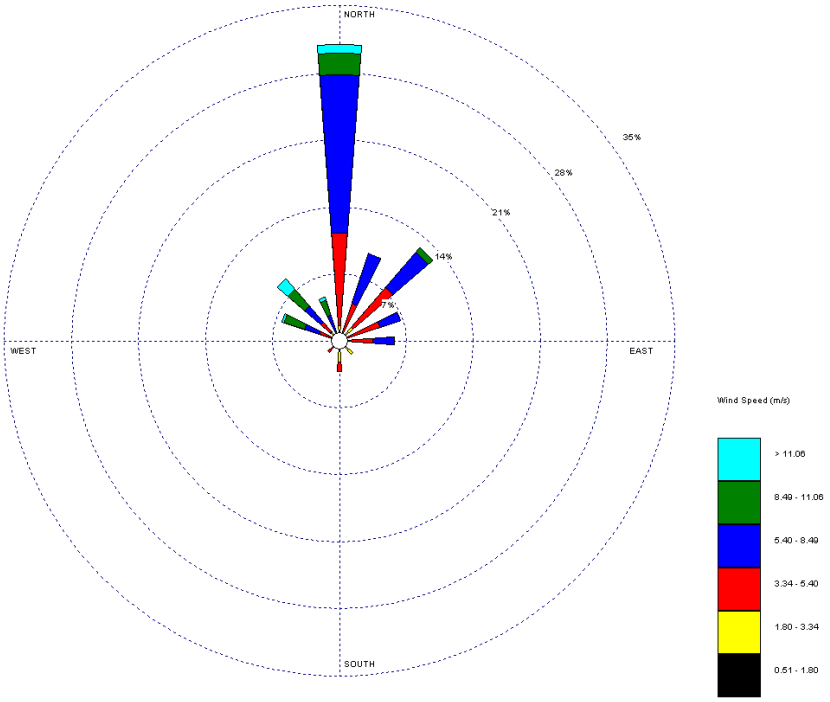
]Based on 1966-2002 data at 1500 GMT



Data 1.1.3 Wind Rose diagram of Jijiga (1/6)

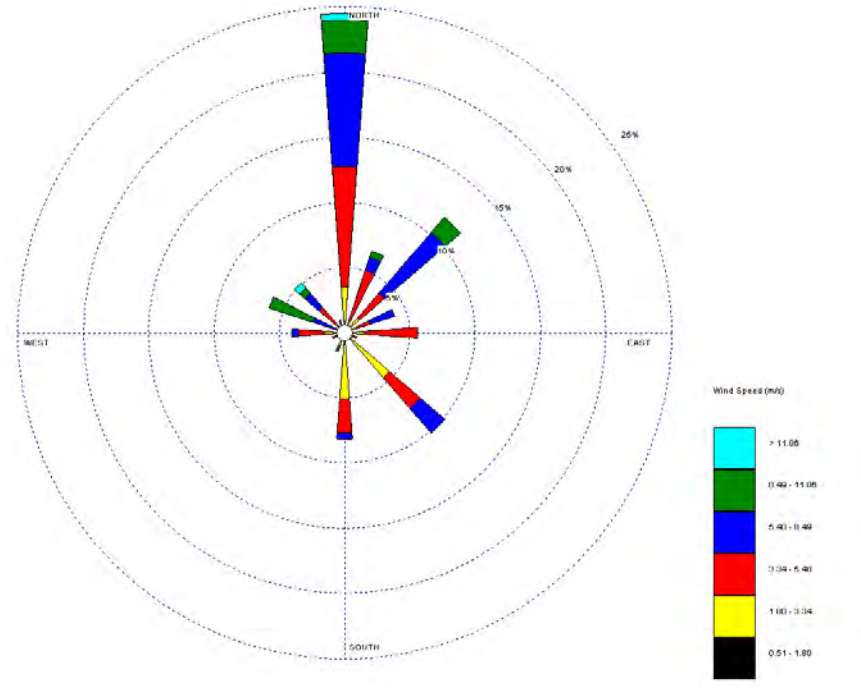
1. Wind-rose diagram of Jijiga for the month of January

Based on 1980-2003 data at 1500 GMT



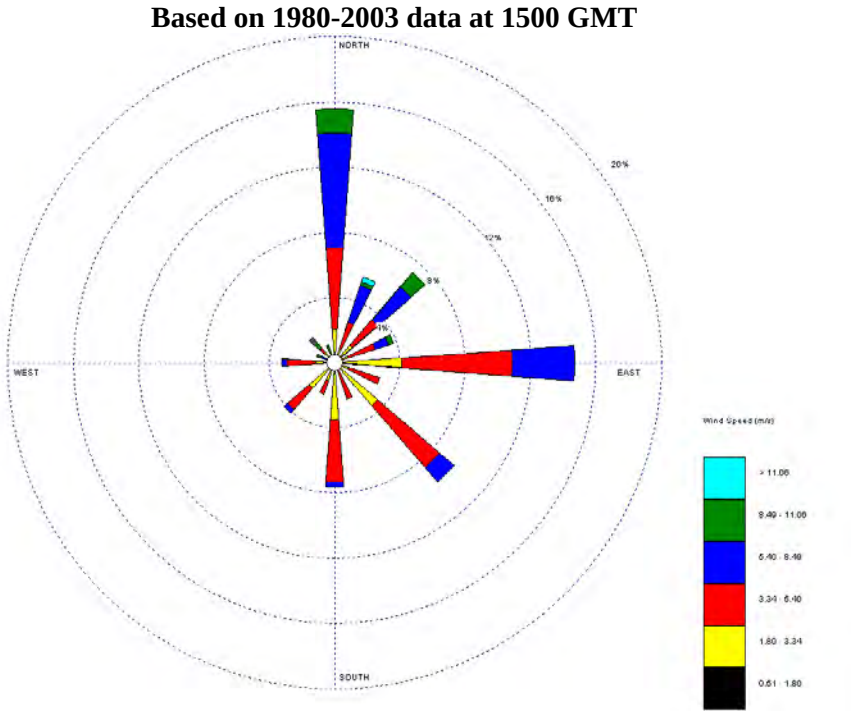
2. Wind-rose diagram of Jijiga for the month of February

Based on 1980-2003 data at 1500 GMT

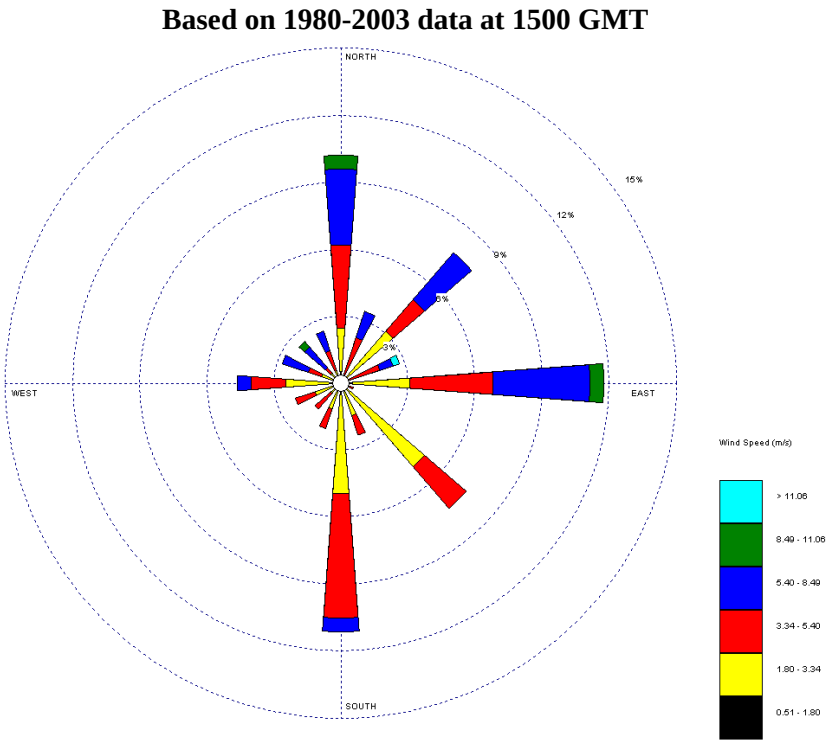


Data 1.1.3 Wind Rose diagram of Jijiga (2/6)

3. Wind-rose diagram of Jijiga for the month of March



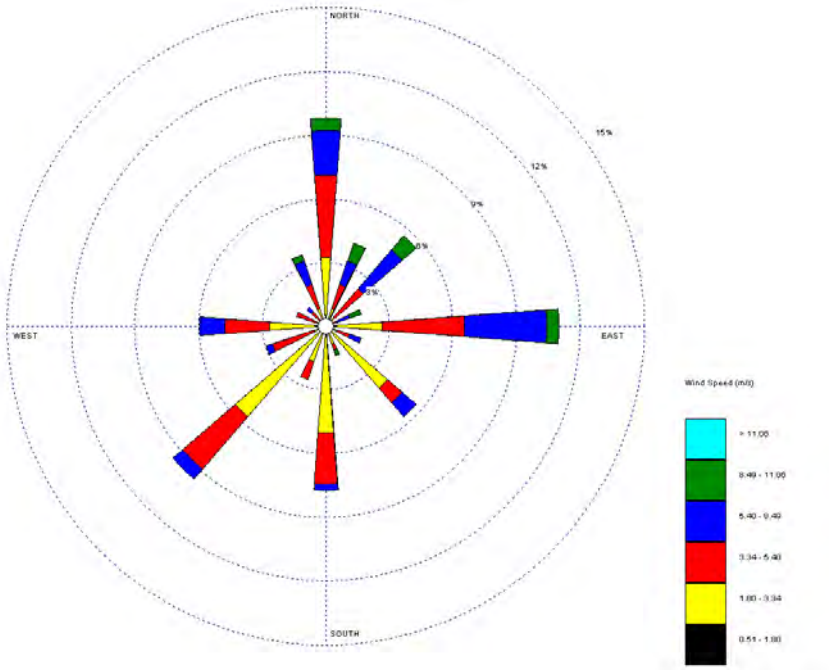
4. Wind-rose diagram of Jijiga for the month of April



Data 1.1.3 Wind Rose diagram of Jijiga (3/6)

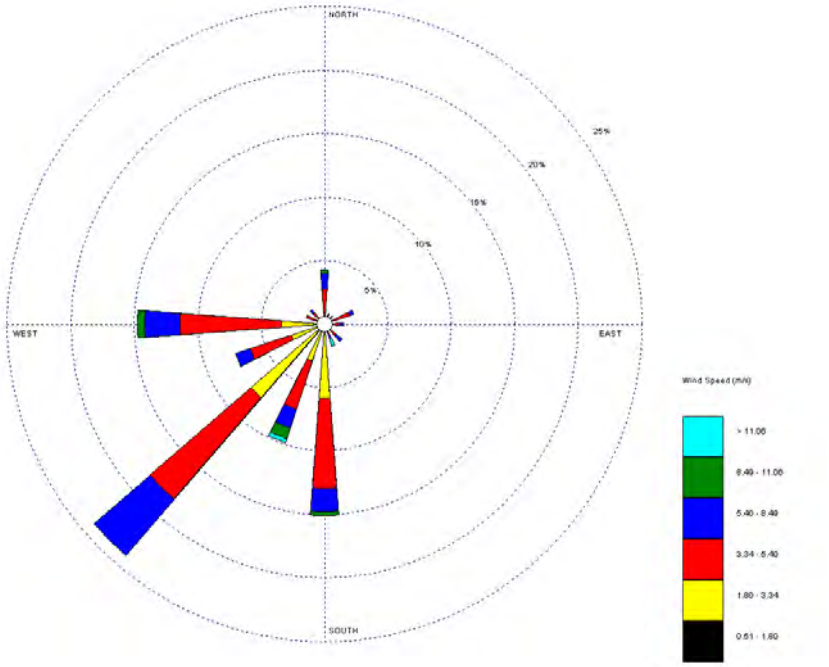
5. Wind-rose diagram of Jijiga for the month of May

Based on 1980-2003 data at 1500 GMT



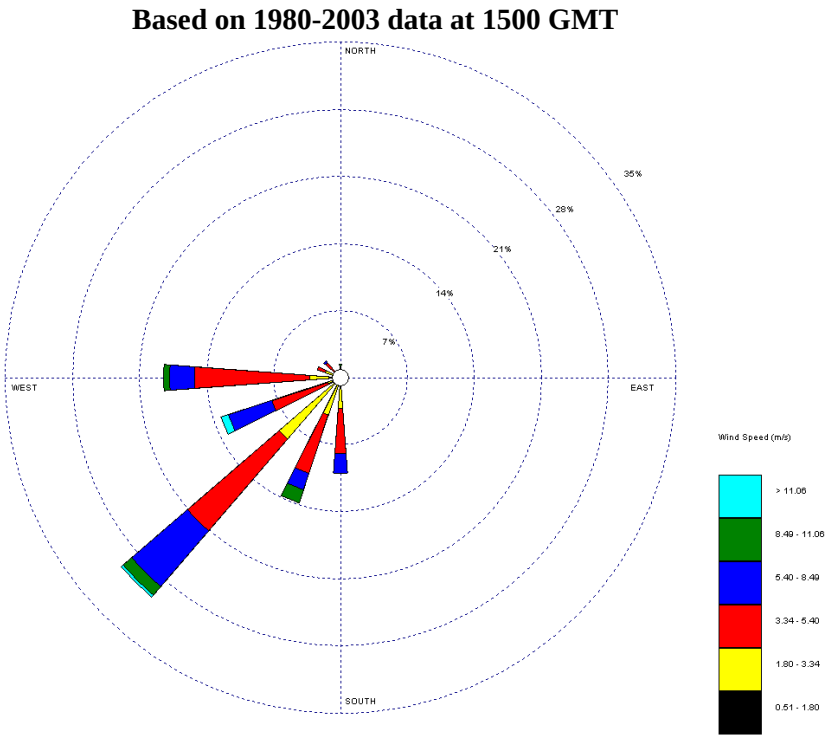
6. Wind-rose diagram of Jijiga for the month of June

Based on 1980-2003 data at 1500 GMT

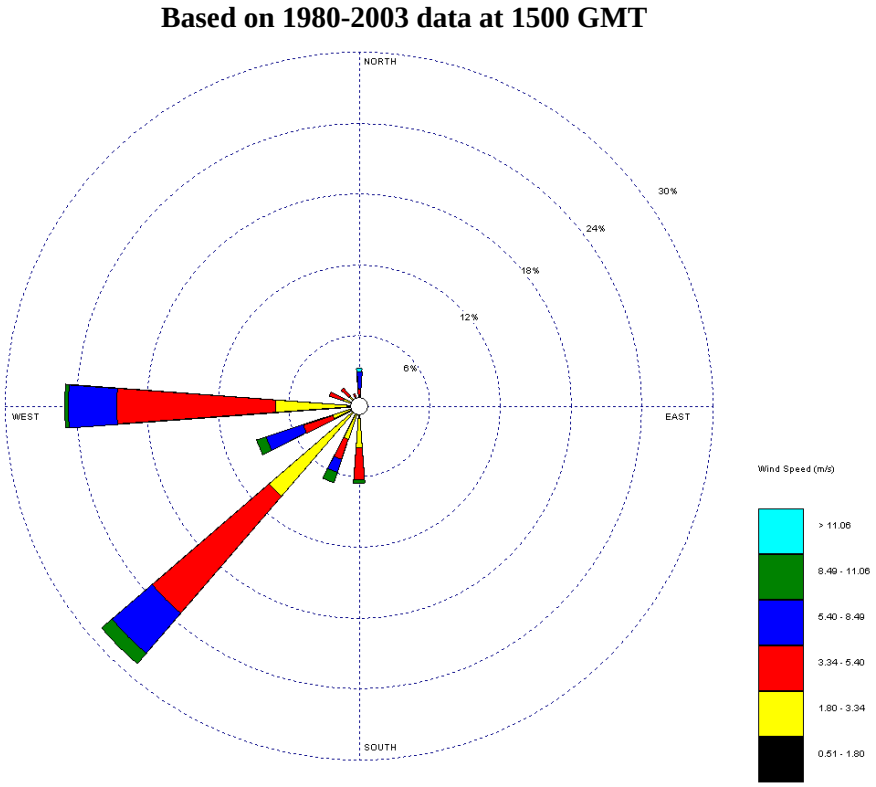


Data 1.1.3 Wind Rose diagram of Jijiga (4/6)

7. Wind-rose diagram of Jijiga for the month of July



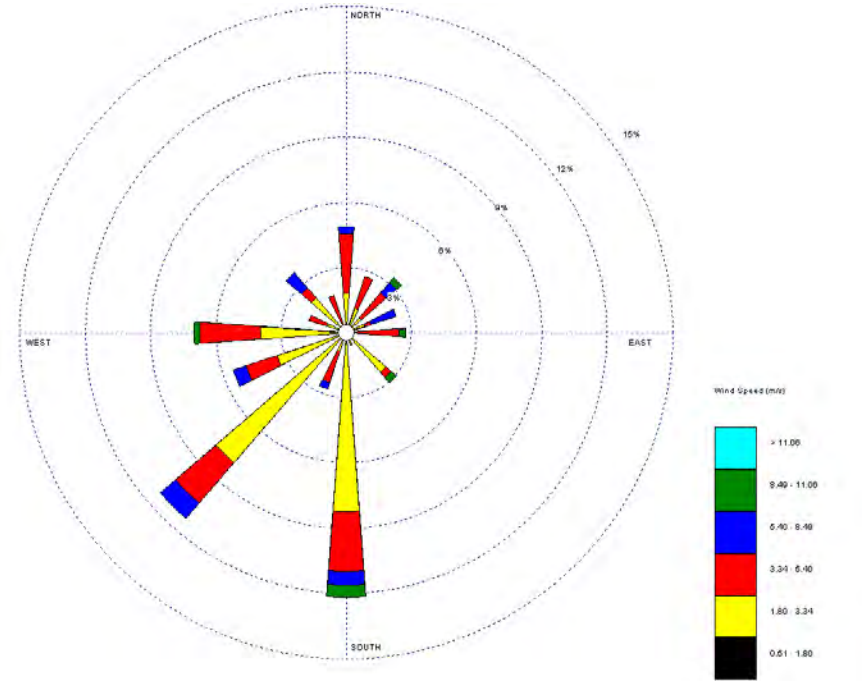
8. Wind-rose diagram of Jijiga for the month of August



Data 1.1.3 Wind Rose diagram of Jijiga (5/6)

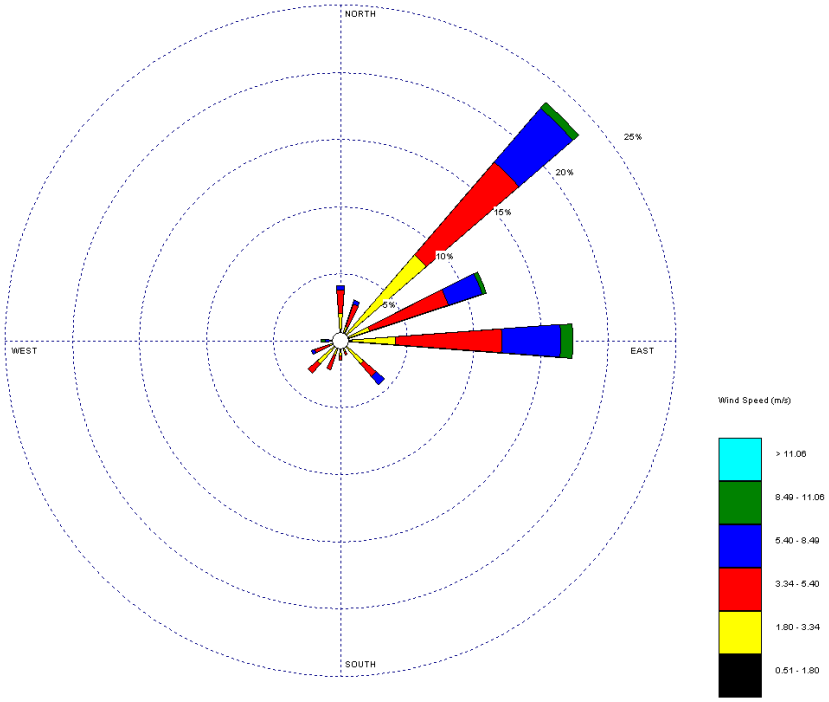
9. Wind-rose diagram of Jijiga for the month of September

Based on 1980-2003 data at 1500 GMT



10. Wind-rose diagram of Jijiga for the month of October

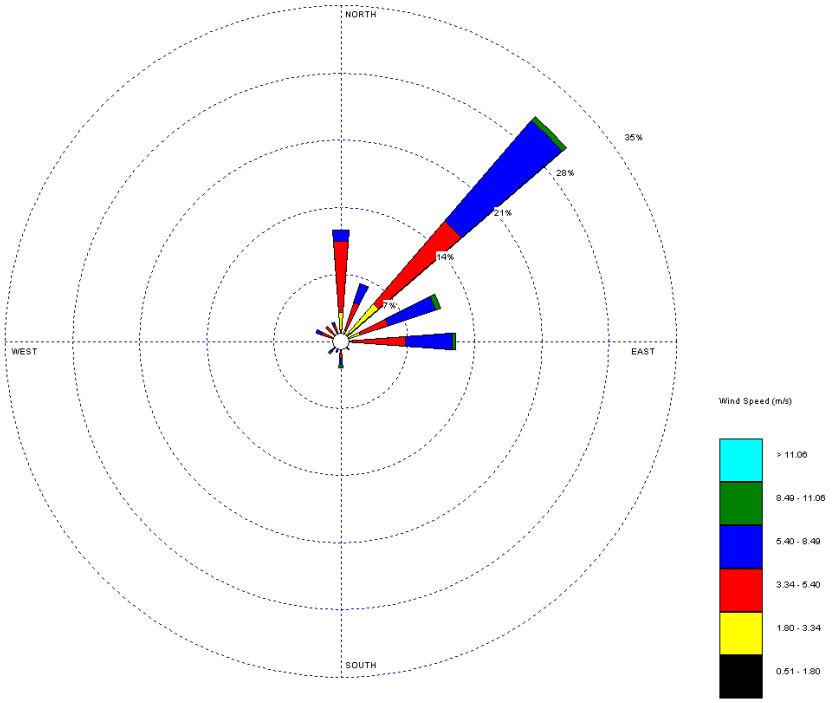
Based on 1980-2003 data at 1500 GMT



Data 1.1.3 Wind Rose diagram of Jijiga (6/6)

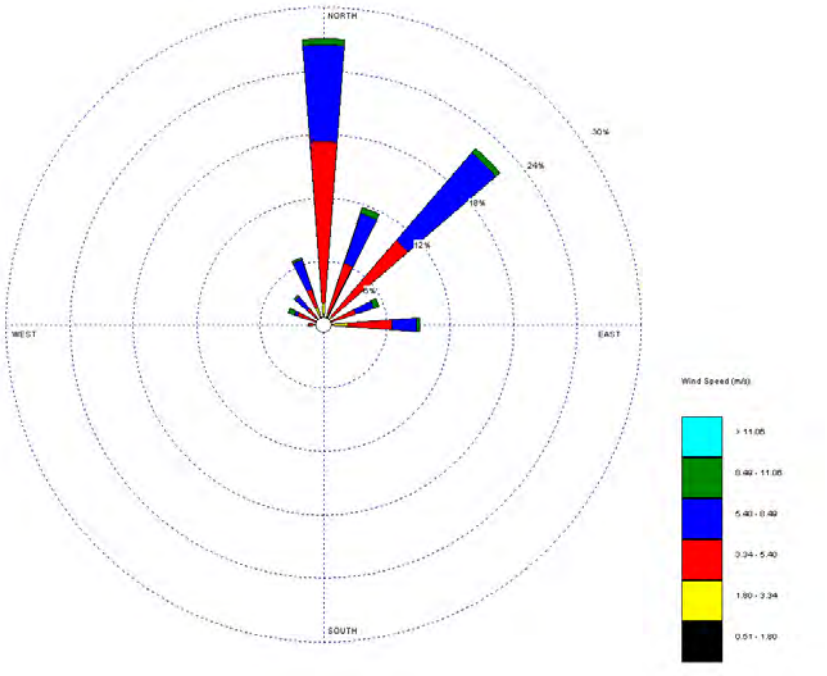
11. Wind-rose diagram of Jijiga for the month of November

Based on 1980-2003 data at 1500 GMT



12. Wind-rose diagram of Jijiga for the month of December

Based on 1980-2003 data at 1500 GMT



Volume.1

2. Geology and Hydrogeology

UTM zone 38N Easting

100000 200000 300000 400000 500000

1100000 1000000 900000 700000 600000 500000

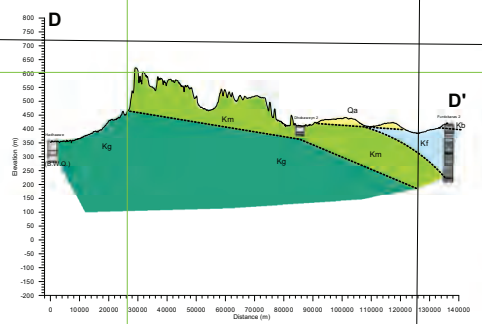
UTM zone 38N Northing

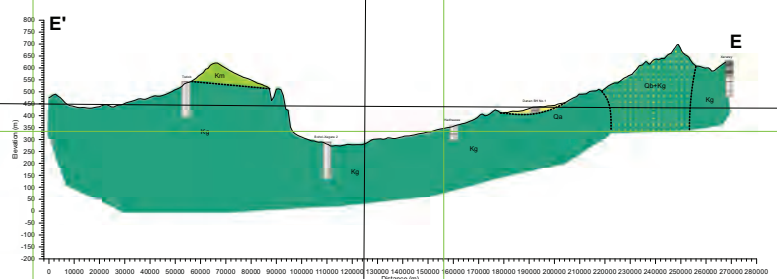
10° N 9° N 8° N 7° N 6° N 5° N

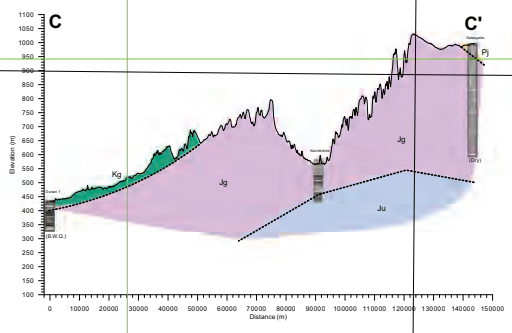
Latitude (Adindan)

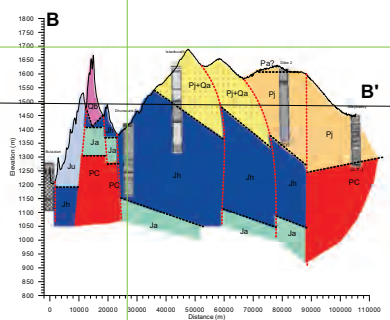
42° E 43° E 44° E 45° E

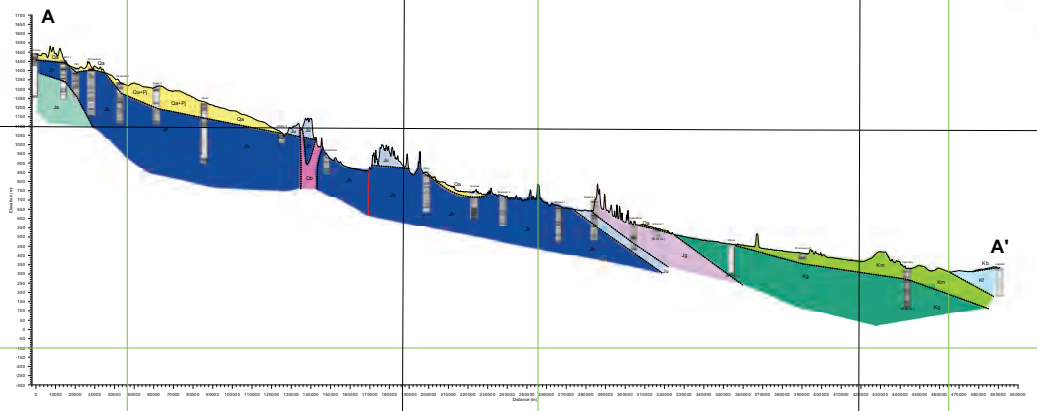
Longitude (Adindan)

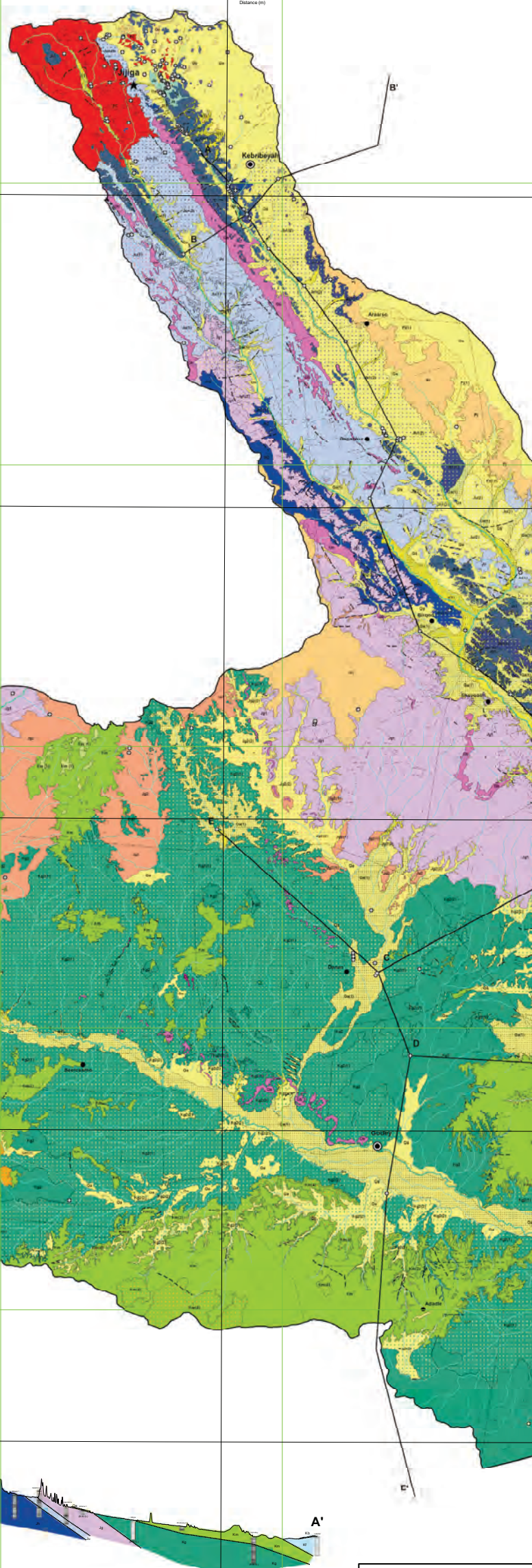












N W E S

0 25 50 100 Km

Legend

- Regional capital
- Zonal capital
- Main cities
- Woreda boundary
- Lineament
- Lineament (Probably correspond to the fault)
- Profile line
- Perennial river
- Non perennial river
- Borehole

Geology

Quaternary

River Deposit: Gravel and sand

r		Present River Deposit
	r(1)	Present River Deposit and terrace deposit (mainly present river deposit)

Alluvial Deposit: Gravel, sand, silt and clay

Qa		Terrace Deposit
	Qa(1)	Terrace Deposit with present river deposit (mainly terrace deposit)

Coluvial Deposit: Sand, silt, clay and gravel

Qc		Coluvial Deposit
	Qc(1)	Coluvial Deposit is scattered in areas of Quaternary deposit.

Late Pliocene - Quaternary

Quaternary Basalt: Basalt lava flow

Qb		Quaternary Basalt (Recent basalt)
	Qb(1)	Quaternary Basalt is overlain by thin Quaternary deposit
	Qb(2)	Quaternary Basalt is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Quaternary Basalt is scattered in areas of Quaternary deposit.

Cenozoic (Unknown Period)

Old basalt: Basalt lava flow

Qv		Old Basalt
	Qv(1)	Old basalt is scattered in areas of Qc.

Late Cretaceous - Early Eocene

Jessoma Sandstone: Variegated quartz sandstone

Pj		Jessoma Sandstone
	Pj(1)	Jessoma Sandstone is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Jessoma Sandstone is scattered in areas of Quaternary deposit.

Late Cretaceous

Beletwein Limestone: Shaly limestone with some sandstone

Kb		Beletwein Limestone
	Kb(1)	Beletwein Limestone is overlain by thin Quaternary deposit.
	Kb(2)	Beletwein Limestone is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Beletwein Limestone is scattered in areas of Quaternary deposit.
	Kb(3)	Beletwein Limestone is overlain by thin Pj

Ferfer Gypsum Formation: Gypsum with sand and marl intercalations

Kf		Ferfer Gypsum Formation
	Kf(1)	Ferfer Gypsum Formation is overlain by thin Quaternary deposit.
	Kf(2)	Ferfer Gypsum Formation is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Ferfer Gypsum Formation is scattered in areas of Quaternary deposit.

Early to Late Cretaceous

Mustahil Limestone: Biogenic limestone and marlstone

Km		Mustahil Limestone
	Km(1)	Mustahil Limestone with flat ground surface
	Km(2)	Mustahil Limestone is overlain by thin Quaternary deposit.
	Km(3)	Mustahil Limestone is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Mustahil Limestone is scattered in areas of Quaternary deposit.
	Km(4)	Mustahil Limestone is overlain by thin Qc.
	Km(5)	Mustahil Limestone is overlain by Qc that does not have a sufficient thickness as aquifer. Or Mustahil Limestone is scattered in areas of Qc.

Late Jurassic - Early Cretaceous

Korahe Gypsum Formation (Main Gypsum Formation): Gypsum evaporates with limestone

Kg2		Korahe Gypsum Formation (Upper unit)
	Kg2(1)	Korahe Gypsum Formation (Upper unit) is overlain by thin Quaternary deposit.
	Kg2(2)	Korahe Gypsum Formation (Upper unit) is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Korahe Gypsum Formation (Upper unit) is scattered in areas of Quaternary deposit.
	Kg2(3)	Qv is scatbered in areas of Korahe Gypsum Formation (Upper unit).
Kg1		Korahe Gypsum Formation (Lower unit)
		Korahe Gypsum Formation (Lower unit) is overlain by thin Qc.

Amba Aradam Sandstone: Variegated quartz sandstone

Ka		Amba Aradam Sandstone

Late Jurassic

Kabridahar Formation: Oolitic limestone, marl and gypsum

Jg2		Kabridahar Formation (Upper unit)
	Jg2(1)	Kabridahar Formation (Upper unit) is overlain by thin Quaternary deposit.
	Jg2(2)	Kabridahar Formation (Upper unit) is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Kabridahar Formation (Upper unit) is scattered in areas of Quaternary deposit.
Jg1		Kabridahar Formation (Lower unit)
	Jg1(1)	Kabridahar Formation (Lower unit) is overlain by thin Quaternary deposit.
	Jg1(2)	Kabridahar Formation (Lower unit) is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Kabridahar Formation (Lower unit) is scattered in areas of Quaternary deposit.

Urandab Formation: Shale and marl with limestone and gypsum

Ju		Urandab Formation
	Ju(1)	Urandab Formation is overlain by thin Quaternary deposit.
	Ju(2)	Urandab Formation is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Urandab Formation is scattered in areas of Quaternary deposit.
	Ju(3)	Qb is scattered in areas of Urandab Formation.

Middle to Late Jurassic

Ju-Jh		The boundary between Urandab Formation and Hammanlei Formation is indefinite by image analysis involving visual inspection.

Hammanlei Formation: Organogenic and oolitic limestone with shale and sandstone intercalations

Jh2		Hammanlei Formation (Upper unit)
		Hammanlei Formation (Upper unit) is overlain by thin Quaternary deposit.
		Hammanlei Formation (Upper unit) is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Hammanlei Formation (Upper unit) is scattered in areas of Quaternary deposit.
Jh1		Hammanlei Formation (Lower unit)
		Hammanlei Formation (Lower unit) is overlain by thin Quaternary deposit.
	Jh1(2)	Hammanlei Formation (Lower unit) is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Hammanlei Formation (Lower unit) is scattered in areas of Quaternary deposit.
		Hammanlei Formation (Lower unit) is overlain by thin Qc.

Triassic(?) - Middle Jurassic

Adigrat Sandstone: Fine to coarse sandstone

Ja		Adigrat Sandstone
	Ja(1)	Adigrat Sandstone is overlain by thin Quaternary deposit that does not have a sufficient thickness as aquifer.

Precambrian

Basement rocks: granite, granite-gneiss, migmatite, amphibolite, diorite

PC		Basement rocks

*: Jh, Jg and Kg are not subdivided into upper and lower units for geological profile. Because the sufficient underground data is not obtained by the limit of the image analysis by visual inspection.

Geological Map	August 2013

THE STUDY ON JARAR VALLEY AND SHEBELE SUB-BASIN WATER SUPPLY DEVELOPMENT PLAN, AND EMERGENCY WATER SUPPLY IN THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

D1.3.1

UTM zone 38N Easting

200000 250000 300000 350000 400000 450000

1050000 1000000 950000 900000

UTM zone 38N Northing

9°20'N 9°0'N 8°40'N 8°20'N 8°0'N

Latitude (Adindan)

42°20'E 42°40'E 43°0'E 43°20'E 43°40'E 44°0'E 44°20'E

Longitude (Adindan)

Jijiga

Kebribeyah

Araarso

Dagahbur

A

A_2

B

B'

N W E S

INDEX MAP

0 10 20 40 Km

Legend

- Regional capital
- Zonal capital
- Main cities
- Woreda boundary
- Lineament
- Lineament (Probably correspond to the fault)
- Profile line
- Perennial river
- Non perennial river
- Borehole

Geology

Quaternary		
River Deposit: Gravel and sand		
r		Present River Deposit
r(1)		Present River Deposit and terrace deposit (mainly present river deposit)
Alluvial Deposit: Gravel, sand, silt and clay		
Qa		Terrace Deposit
Qa(1)		Terrace Deposit with present river deposit (mainly terrace deposit)
Colluvial Deposit: Sand, silt, clay and gravel		
Qc		Colluvial Deposit
Qc(1)		Colluvial Deposit is scattered in areas of Quaternary deposit.
Late Pliocene - Quaternary		
Quaternary Basalt: Basalt lava flow		
Qb		Quaternary Basalt (Recent basalt)
Qb(1)		Quaternary Basalt is overlain by thin Quaternary deposit
Qb(2)		Quaternary Basalt is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Quaternary Basalt is scattered in areas of Quaternary deposit.
Cenozoic (Unknown Period)		
Old basalt: Basalt lava flow		
Qv		Old Basalt
Qv(1)		Old basalt is scattered in areas of Qc.
Late Cretaceous - Early Eocene		
Jessoma Sandstone: Variegated quartz sandstone		
Pj		Jessoma Sandstone
Pj(1)		Jessoma Sandstone is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Jessoma Sandstone is scattered in areas of Quaternary deposit.
Late Cretaceous		
Beletwein Limestone: Shaly limestone with some sandstone		
Kb		Beletwein Limestone
Kb(1)		Beletwein Limestone is overlain by thin Quaternary deposit.
Kb(2)		Beletwein Limestone is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Beletwein Limestone is scattered in areas of Quaternary deposit.
Kb(3)		Beletwein Limestone is overlain by thin Pj
Ferfer Gypsum Formation: Gypsum with sand and marl intercalations		
Kf		Ferfer Gypsum Formation
Kf(1)		Ferfer Gypsum Formation is overlain by thin Quaternary deposit.
Kf(2)		Ferfer Gypsum Formation is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Ferfer Gypsum Formation is scattered in areas of Quaternary deposit.
Early to Late Cretaceous		
Mustahil Limestone: Biogenic limestone and marlstone		
Km		Mustahil Limestone
Km(1)		Mustahil Limestone with flat ground surface
Km(2)		Mustahil Limestone is overlain by thin Quaternary deposit.
Km(3)		Mustahil Limestone is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Mustahil Limestone is scattered in areas of Quaternary deposit.
Km(4)		Mustahil Limestone is overlain by thin Qc.
Km(5)		Mustahil Limestone is overlain by Qc that does not have a sufficient thickness as aquifer. Or Mustahil Limestone is scattered in areas of Qc.
Late Jurassic - Early Cretaceous		
Korahe Gypsum Formation (Main Gypsum Formation): Gypsum evaporates with limestone		
Kg2		Korahe Gypsum Formation (Upper unit)
Kg2(1)		Korahe Gypsum Formation (Upper unit) is overlain by thin Quaternary deposit.
Kg2(2)		Korahe Gypsum Formation (Upper unit) is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Korahe Gypsum Formation (Upper unit) is scattered in areas of Quaternary deposit.
Kg2(3)		Qv is scattered in areas of Korahe Gypsum Formation (Upper unit).
Kg1		Korahe Gypsum Formation (Lower unit)
Kg1(1)		Korahe Gypsum Formation (Lower unit) is overlain by thin Qc.
Amba Aradam Sandstone: Variegated quartz sandstone		
Ka		Amba Aradam Sandstone
Late Jurassic		
Kabridahar Formation: Oolitic limestone, marl and gypsum		
Jg2		Kabridahar Formation (Upper unit)
Jg2(1)		Kabridahar Formation (Upper unit) is overlain by thin Quaternary deposit.
Jg2(2)		Kabridahar Formation (Upper unit) is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Kabridahar Formation (Upper unit) is scattered in areas of Quaternary deposit.
Jg1		Kabridahar Formation (Lower unit)
Jg1(1)		Kabridahar Formation (Lower unit) is overlain by thin Quaternary deposit.
Jg1(2)		Kabridahar Formation (Lower unit) is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Kabridahar Formation (Lower unit) is scattered in areas of Quaternary deposit.
Urandab Formation: Shale and marl with limestone and gypsum		
Ju		Urandab Formation
Ju(1)		Urandab Formation is overlain by thin Quaternary deposit.
Ju(2)		Urandab Formation is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Urandab Formation is scattered in areas of Quaternary deposit.
Ju(3)		Qb is scattered in areas of Urandab Formation.
Middle to Late Jurassic		
Ju+Jh		The boundary between Urandab Formation and Hammaniei Formation is indefinite by image analysis involving visual inspection.
Hammaniei Formation: Organogenic and oolitic limestone with shale and sandstone intercalations		
Jh2		Hammaniei Formation (Upper unit)
Jh2(1)		Hammaniei Formation (Upper unit) is overlain by thin Quaternary deposit.
Jh2(2)		Hammaniei Formation (Upper unit) is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Hammaniei Formation (Upper unit) is scattered in areas of Quaternary deposit.
Jh1		Hammaniei Formation (Lower unit)
Jh1(1)		Hammaniei Formation (Lower unit) is overlain by thin Quaternary deposit.
Jh1(2)		Hammaniei Formation (Lower unit) is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Hammaniei Formation (Lower unit) is scattered in areas of Quaternary deposit.
Jh1(3)		Hammaniei Formation (Lower unit) is overlain by thin Qc.
Triassic(?) - Middle Jurassic		
Adigrat Sandstone: Fine to coarse sandstone		
Ja		Adigrat Sandstone
Ja(1)		Adigrat Sandstone is overlain by thin Quaternary deposit that does not have a sufficient thickness as aquifer.
Precambrian		
Basement rocks: granite, granite-gneiss, migmatite, amphibolite, diorite		
PC		Basement rocks

*: Jh, Jg and Kg are not subdivided into upper and lower units for geological profile. Because the sufficient underground data is not obtained by the limit of the image analysis by visual inspection.

On the geological columnar sections of the profiles, refer to Annex of the Explanatory Text of Geological and Hydrogeological Maps.

B — B'

Elevation (m)

Distance (m)

A — A_2 — A'

Distance (m)

Geological Map	August 2013
THE STUDY ON JARAR VALLEY AND SHEBELE SUB-BASIN WATER SUPPLY DEVELOPMENT PLAN, AND EMERGENCY WATER SUPPLY IN THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	

Geological Map	August 2013
THE STUDY ON JARAR VALLEY AND SHEBELE SUB-BASIN WATER SUPPLY DEVELOPMENT PLAN, AND EMERGENCY WATER SUPPLY IN THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	

UTM zone 38N Easting

50000 100000 150000 200000 250000 300000

UTM zone 38N Northing

900000 850000 800000 750000

Latitude (Adindan)

8°0'N 7°40'N 7°20'N 7°0'N 6°40'N

Longitude (Adindan)

41°0'E 41°20'E 41°40'E 42°0'E 42°20'E 42°40'E 43°0'E 43°20'E

0 10 20 40 Km

N W E S

Legend

- Regional capital
- Zonal capital
- Main cities
- Woreda boundary
- Lineament
- Lineament (Probably correspond to the fault)
- Profile line
- Perennial river
- Non perennial river
- Borehole

Geology

Quaternary

River Deposit: Gravel and sand
- r — Present River Deposit
- r(1) — Present River Deposit and terrace deposit (mainly present river deposit)

Alluvial Deposit: Gravel, sand, silt and clay
- Qa — Terrace Deposit
- Qa(1) — Terrace Deposit with present river deposit (mainly terrace deposit)

Colluvial Deposit: Sand, silt, clay and gravel
- Qc — Colluvial Deposit
- Qc(1) — Colluvial Deposit is scattered in areas of Quaternary deposit.

Late Pliocene - Quaternary

Quaternary Basalt: Basalt lava flow
- Qb — Quaternary Basalt (Recent basalt)
- Qb(1) — Quaternary Basalt is overlain by thin Quaternary deposit
- Qb(2) — Quaternary Basalt is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Quaternary Basalt is scattered in areas of Quaternary deposit.

Cenozoic (Unknown Period)

Old basalt: Basalt lava flow
- Qv — Old Basalt
- Qv(1) — Old basalt is scattered in areas of Qc.

Late Cretaceous - Early Eocene

Jessoma Sandstone: Variegated quartz sandstone
- Pj — Jessoma Sandstone
- Pj(1) — Jessoma Sandstone is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Jessoma Sandstone is scattered in areas of Quaternary deposit.

Late Cretaceous

Beletwein Limestone: Shaly limestone with some sandstone
- Kb — Beletwein Limestone
- Kb(1) — Beletwein Limestone is overlain by thin Quaternary deposit.
- Kb(2) — Beletwein Limestone is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Beletwein Limestone is scattered in areas of Quaternary deposit.
- Kb(3) — Beletwein Limestone is overlain by thin Pj.

Ferfer Gypsum Formation: Gypsum with sand and marl intercalations
- Kf — Ferfer Gypsum Formation
- Kf(1) — Ferfer Gypsum Formation is overlain by thin Quaternary deposit.
- Kf(2) — Ferfer Gypsum Formation is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Ferfer Gypsum Formation is scattered in areas of Quaternary deposit.

Early to Late Cretaceous

Mustahil Limestone: Biogenic limestone and marlstone
- Km — Mustahil Limestone
- Km(1) — Mustahil Limestone with flat ground surface
- Km(2) — Mustahil Limestone is overlain by thin Quaternary deposit.
- Km(3) — Mustahil Limestone is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Mustahil Limestone is scattered in areas of Quaternary deposit.
- Km(4) — Mustahil Limestone is overlain by thin Qc.
- Km(5) — Mustahil Limestone is overlain by Qc that does not have a sufficient thickness as aquifer. Or Mustahil Limestone is scattered in areas of Qc.

Late Jurassic - Early Cretaceous

Korahe Gypsum Formation (Main Gypsum Formation): Gypsum evaporates with limestone
- Kg2 — Korahe Gypsum Formation (Upper unit)
- Kg2(1) — Korahe Gypsum Formation (Upper unit) is overlain by thin Quaternary deposit.
- Kg2(2) — Korahe Gypsum Formation (Upper unit) is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Korahe Gypsum Formation (Upper unit) is scattered in areas of Quaternary deposit.
- Kg2(3) — Qv is scattered in areas of Korahe Gypsum Formation (Upper unit).
- Kg1 — Korahe Gypsum Formation (Lower unit)
- Kg1(1) — Korahe Gypsum Formation (Lower unit) is overlain by thin Qc.

Amba Aradam Sandstone: Variegated quartz sandstone
- Ka — Amba Aradam Sandstone

Late Jurassic

Kabridahar Formation: Oolitic limestone, marl and gypsum
- Jg2 — Kabridahar Formation (Upper unit)
- Jg2(1) — Kabridahar Formation (Upper unit) is overlain by thin Quaternary deposit.
- Jg2(2) — Kabridahar Formation (Upper unit) is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Kabridahar Formation (Upper unit) is scattered in areas of Quaternary deposit.
- Jg1 — Kabridahar Formation (Lower unit)
- Jg1(1) — Kabridahar Formation (Lower unit) is overlain by thin Quaternary deposit.
- Jg1(2) — Kabridahar Formation (Lower unit) is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Kabridahar Formation (Lower unit) is scattered in areas of Quaternary deposit.

Urandab Formation: Shale and marl with limestone and gypsum
- Ju — Urandab Formation
- Ju(1) — Urandab Formation is overlain by thin Quaternary deposit.
- Ju(2) — Urandab Formation is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Urandab Formation is scattered in areas of Quaternary deposit.
- Ju(3) — Qb is scattered in areas of Urandab Formation.

Middle to Late Jurassic
- The boundary between Urandab Formation and Hammanlei Formation is indefinite by image analysis involving visual inspection.

Hammanlei Formation: Organogenic and oolitic limestone with shale and sandstone intercalations
- Jh2 — Hammanlei Formation (Upper unit)
- Jh2(1) — Hammanlei Formation (Upper unit) is overlain by thin Quaternary deposit.
- Jh2(2) — Hammanlei Formation (Upper unit) is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Hammanlei Formation (Upper unit) is scattered in areas of Quaternary deposit.
- Jh1 — Hammanlei Formation (Lower unit)
- Jh1(1) — Hammanlei Formation (Lower unit) is overlain by thin Quaternary deposit.
- Jh1(2) — Hammanlei Formation (Lower unit) is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Hammanlei Formation (Lower unit) is scattered in areas of Quaternary deposit.
- Jh1(3) — Hammanlei Formation (Lower unit) is overlain by thin Qc.

Triassic(?) - Middle Jurassic

Adigrat Sandstone: Fine to coarse sandstone
- Ja — Adigrat Sandstone
- Ja(1) — Adigrat Sandstone is overlain by thin Quaternary deposit that does not have a sufficient thickness as aquifer.

Precambrian

Basement rocks: granite, granite-gneiss, migmatite, amphibolite, diorite
- PC — Basement rocks

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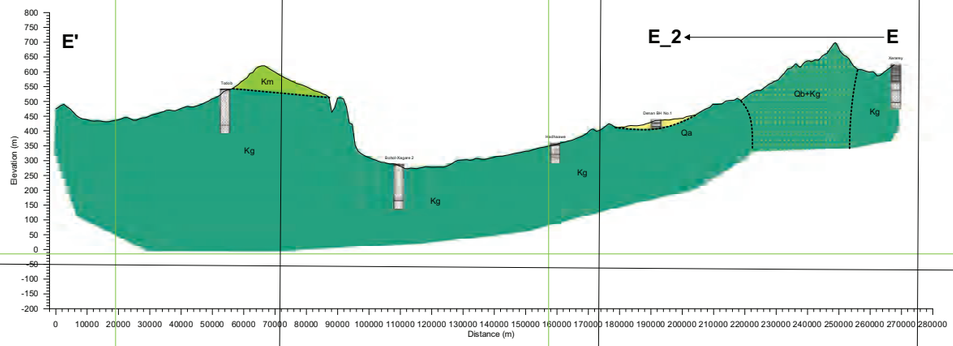
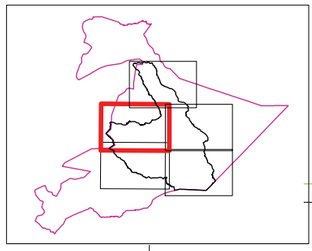


INDEX MAP



UTM zone 38N Easting

350000 400000 450000 500000 550000

8°0'N 7°40'N 7°20'N 7°0'N 6°40'N

Latitude (Adindan)

850000 800000 750000

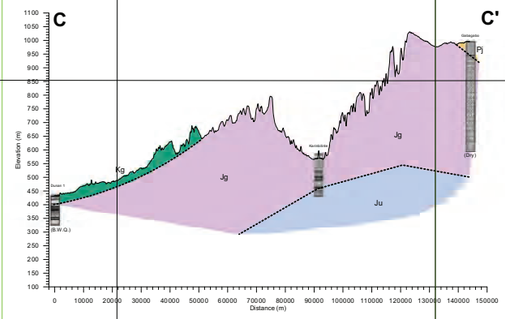
UTM zone 38N Northing

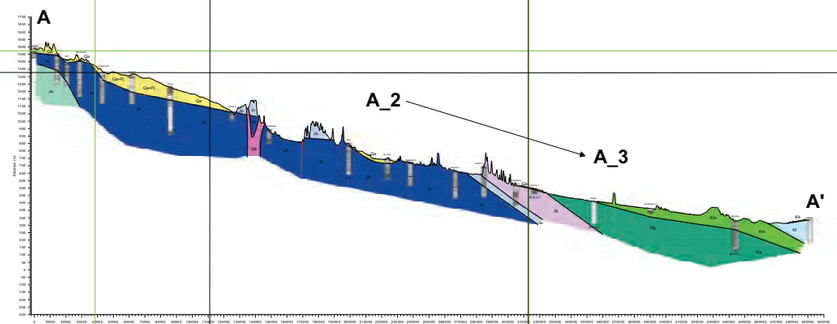
43°20'E 43°40'E 44°0'E 44°20'E 44°40'E 45°0'E 45°20'E 45°40'E

Longitude (Adindan)

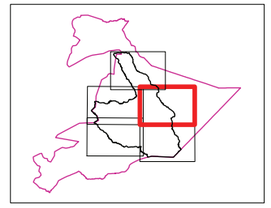
Birqod Shaygosh Kebridahar Danan

A_2 A_3 A A' C C'





INDEX MAP



0 10 20 40 Km

N W E S

Legend

- Regional capital
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Colluvial Deposit: Sand, silt, clay and gravel

Qc	Colluvial Deposit
Qc(1)	Colluvial Deposit is scattered in areas of Quaternary deposit.

Late Pliocene - Quaternary

Quaternary Basalt: Basalt lava flow

Qb	Quaternary Basalt (Recent basalt)
Qb(1)	Quaternary Basalt is overlain by thin Quaternary deposit
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Old basalt: Basalt lava flow

Qv	Old Basalt
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Late Cretaceous - Early Eocene

Jessoma Sandstone: Variegated quartz sandstone

Pj	Jessoma Sandstone
Pj(1)	Jessoma Sandstone is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Jessoma Sandstone is scattered in areas of Quaternary deposit.

Late Cretaceous

Beletwein Limestone: Shaly limestone with some sandstone

Kb	Beletwein Limestone
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Ferfer Gypsum Formation: Gypsum with sand and marl intercalations

Kf	Ferfer Gypsum Formation
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Early to Late Cretaceous

Mustahil Limestone: Biogenic limestone and marlstone

Km	Mustahil Limestone
Km(1)	Mustahil Limestone with flat ground surface
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Late Jurassic - Early Cretaceous

Korahe Gypsum Formation (Main Gypsum Formation): Gypsum evaporates with limestone

Kg2	Korahe Gypsum Formation (Upper unit)
Kg2(1)	Korahe Gypsum Formation (Upper unit) is overlain by thin Quaternary deposit.
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Kg1	Korahe Gypsum Formation (Lower unit)
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Amba Aradam Sandstone: Variegated quartz sandstone

Ka	Amba Aradam Sandstone

Late Jurassic

Kabridahar Formation: Oolitic limestone, marl and gypsum

Jg2	Kabridahar Formation (Upper unit)
Jg2(1)	Kabridahar Formation (Upper unit) is overlain by thin Quaternary deposit.
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Jg1(1)	Kabridahar Formation (Lower unit) is overlain by thin Quaternary deposit.
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Urandab Formation: Shale and marl with limestone and gypsum

Ju	Urandab Formation
Ju(1)	Urandab Formation is overlain by thin Quaternary deposit.
Ju(2)	Urandab Formation is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Urandab Formation is scattered in areas of Quaternary deposit.
Ju(3)	Qb is scattered in areas of Urandab Formation.

Middle to Late Jurassic

Jg2-Ju	The boundary between Urandab Formation and Hammanlei Formation is indefinite by image analysis including visual inspection.

Hammanlei Formation: Organogenic and oolitic limestone with shale and sandstone intercalations

Jh2	Hammanlei Formation (Upper unit)
Jh2(1)	Hammanlei Formation (Upper unit) is overlain by thin Quaternary deposit.
Jh2(2)	Hammanlei Formation (Upper unit) is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Hammanlei Formation (Upper unit) is scattered in areas of Quaternary deposit.
Jh1	Hammanlei Formation (Lower unit)
Jh1(1)	Hammanlei Formation (Lower unit) is overlain by thin Quaternary deposit.
Jh1(2)	Hammanlei Formation (Lower unit) is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Hammanlei Formation (Lower unit) is scattered in areas of Quaternary deposit.
	Hammanlei Formation (Lower unit) is overlain by thin Qc.

Triassic(?) - Middle Jurassic

Adigrat Sandstone: Fine to coarse sandstone

Ja	Adigrat Sandstone
Ja(1)	Adigrat Sandstone is overlain by thin Quaternary deposit that does not have a sufficient thickness as aquifer.

Precambrian

Basement rocks: granite, granite-gneiss, migmatite, amphibolite, diorite

PC	Basement rocks

* Jh, Jg and Kg are not subdivided into upper and lower units for geological profile. Because the sufficient underground data is not obtained by the limit of the image analysis by visual inspection.

On the geological columnar sections of the profiles, refer to Annex of the Explanatory Text of Geological and Hydrogeological Maps.

Geological Map

August 2013

THE STUDY ON JARAR VALLEY AND SHEBELE SUB-BASIN WATER SUPPLY DEVELOPMENT PLAN, AND EMERGENCY WATER SUPPLY IN THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

D1.2-4

UTM zone 38N Easting

100000 150000 200000 250000 300000 350000

Latitude (Adindan)

6°20'N 6°0'N 5°40'N 5°20'N 5°0'N

UTM zone 38N Northing

700000 650000 600000 550000

41°40'E 42°0'E 42°20'E 42°40'E 43°0'E 43°20'E 43°40'E

Longitude (Adindan)

Legend

Geology

Quaternary

River Deposit: Gravel and sand

r		Present River Deposit
r	Qa(r1) / Qa(r2)	Present River Deposit and terrace deposit (mainly present river deposit)

Alluvial Deposit: Gravel, sand, silt and clay

Qa		Terrace Deposit
Qa	Qa(r1) / Qa(r2)	Terrace Deposit with present river deposit (mainly terrace deposit)

Colluvial Deposit: Sand, silt, clay and gravel

Qc		Colluvial Deposit
Qc	Qc(1)	Colluvial Deposit is scattered in areas of Quaternary deposit.

Late Pliocene - Quaternary

Quaternary Basalt: Basalt lava flow

Qb		Quaternary Basalt (Recent basalt)
Qb	Qb(1)	Quaternary Basalt is overlain by thin Quaternary deposit
Qb	Qb(2)	Quaternary Basalt is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Quaternary Basalt is scattered in areas of Quaternary deposit.

Cenozoic (Unknown Period)

Old basalt: Basalt lava flow

Qc		Old Basalt
Qc	Qc(1)	Old basalt is scattered in areas of Qc.

Late Cretaceous - Early Eocene

Jessoma Sandstone: Variegated quartz sandstone

Pj		Jessoma Sandstone
Pj	Pj(1)	Jessoma Sandstone is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Jessoma Sandstone is scattered in areas of Quaternary deposit.

Late Cretaceous

Beletewin Limestone: Shaly limestone with some sandstone

Kb		Beletewin Limestone
Kb	Kb(1)	Beletewin Limestone is overlain by thin Quaternary deposit.
Kb	Kb(2)	Beletewin Limestone is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Beletewin Limestone is scattered in areas of Quaternary deposit.
Kb	Kb(3)	Beletewin Limestone is overlain by thin Pj

Ferfer Gypsum Formation: Gypsum with sand and marl intercalations

Kf		Ferfer Gypsum Formation
Kf	Kf(1)	Ferfer Gypsum Formation is overlain by thin Quaternary deposit.
Kf	Kf(2)	Ferfer Gypsum Formation is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Ferfer Gypsum Formation is scattered in areas of Quaternary deposit.

Early to Late Cretaceous

Mustahil Limestone: Biogenic limestone and marlstone

Km		Mustahil Limestone
Km	Km(1)	Mustahil Limestone with flat ground surface
Km	Km(2)	Mustahil Limestone is overlain by thin Quaternary deposit.
Km	Km(3)	Mustahil Limestone is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Mustahil Limestone is scattered in areas of Quaternary deposit.
Km	Km(4)	Mustahil Limestone is overlain by thin Qc.
Km	Km(5)	Mustahil Limestone is overlain by Qc that does not have a sufficient thickness as aquifer. Or Mustahil Limestone is scattered in areas of Qc.

Late Jurassic - Early Cretaceous

Korahe Gypsum Formation (Main Gypsum Formation): Gypsum evaporates with limestone

Kg2		Korahe Gypsum Formation (Upper unit)
Kg2	Kg2(1)	Korahe Gypsum Formation (Upper unit) is overlain by thin Quaternary deposit.
Kg2	Kg2(2)	Korahe Gypsum Formation (Upper unit) is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Korahe Gypsum Formation (Upper unit) is scattered in areas of Quaternary deposit.
Kg2	Kg2(3)	Qr is scattered in areas of Korahe Gypsum Formation (Upper unit).
Kg1		Korahe Gypsum Formation (Lower unit)
Kg1		Korahe Gypsum Formation (Lower unit) is overlain by thin Qc.

Amba Aradam Sandstone: Variegated quartz sandstone

Ja		Amba Aradam Sandstone

Late Jurassic

Kabridahar Formation: Oolitic limestone, marl and gypsum

Jg2		Kabridahar Formation (Upper unit)
Jg2	Jg2(1)	Kabridahar Formation (Upper unit) is overlain by thin Quaternary deposit.
Jg2	Jg2(2)	Kabridahar Formation (Upper unit) is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Kabridahar Formation (Upper unit) is scattered in areas of Quaternary deposit.
Jg1		Kabridahar Formation (Lower unit)
Jg1	Jg1(1)	Kabridahar Formation (Lower unit) is overlain by thin Quaternary deposit.
Jg1	Jg1(2)	Kabridahar Formation (Lower unit) is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Kabridahar Formation (Lower unit) is scattered in areas of Quaternary deposit

Urandab Formation: Shale and marl with limestone and gypsum

Ju		Urandab Formation
Ju	Ju(1)	Urandab Formation is overlain by thin Quaternary deposit.
Ju	Ju(2)	Urandab Formation is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Urandab Formation is scattered in areas of Quaternary deposit.
Ju	Ju(3)	Qb is scattered in areas of Urandab Formation.

Middle to Late Jurassic

Ju+Jh		The boundary between Urandab Formation and Hammanlei Formation is indefinite by image analysis involving visual inspection.

Hammanlei Formation: Organogenic and oolitic limestone with shale and sandstone intercalations

Jh2		Hammanlei Formation (Upper unit)
Jh2		Hammanlei Formation (Upper unit) is overlain by thin Quaternary deposit.
Jh2		Hammanlei Formation (Upper unit) is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Hammanlei Formation (Upper unit) is scattered in areas of Quaternary deposit.
Jh1		Hammanlei Formation (Lower unit)
Jh1		Hammanlei Formation (Lower unit) is overlain by thin Quaternary deposit.
Jh1		Hammanlei Formation (Lower unit) is overlain by Quaternary deposit that does not have a sufficient thickness as aquifer. Or Hammanlei Formation (Lower unit) is scattered in areas of Quaternary deposit.
Jh1		Hammanlei Formation (Lower unit) is overlain by thin Qc.

Triassic(?) - Middle Jurassic

Adigrat Sandstone: Fine to coarse sandstone

Ja		Adigrat Sandstone
Ja	Ja(1)	Adigrat Sandstone is overlain by thin Quaternary deposit that does not have a sufficient thickness as aquifer.

Precambrian

Basement rocks: granite, granite-gneiss, migmatite, amphibolite, diorite

PC		Basement rocks

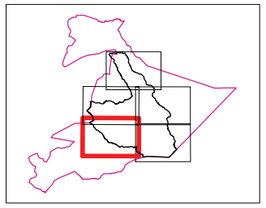
* Jh, Jg and Kg are not subdivided into upper and lower units for geological profile. Because the sufficient underground data is not obtained by the limit of the image analysis by visual inspection.

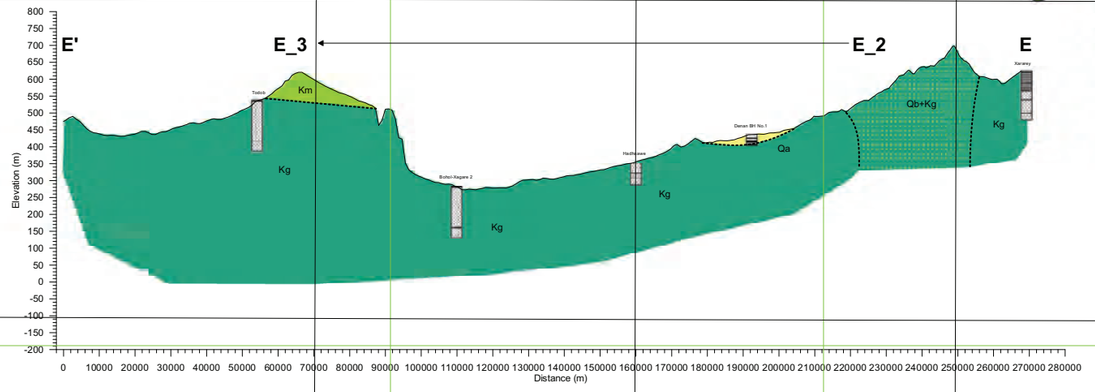
On the geological columnar sections of the profiles, refer to Annex of the Explanatory Text of Geological and Hydrogeological Maps.

★ Regional capital
◉ Zonal capital
● Main cities
Woreda boundary
Lineament
Lineament (Probably correspond to the fault)
Profile line
Perennial river
Non perennial river
Borehole

0 10 20 40 Km

INDEX MAP





Geological Map

August 2013

THE STUDY ON JARAR VALLEY AND SHEBELE SUB-BASIN WATER SUPPLY DEVELOPMENT PLAN, AND EMERGENCY WATER SUPPLY IN THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

UTM zone 38N Easting

350000 400000 450000 500000 550000

Latitude (Adindan)

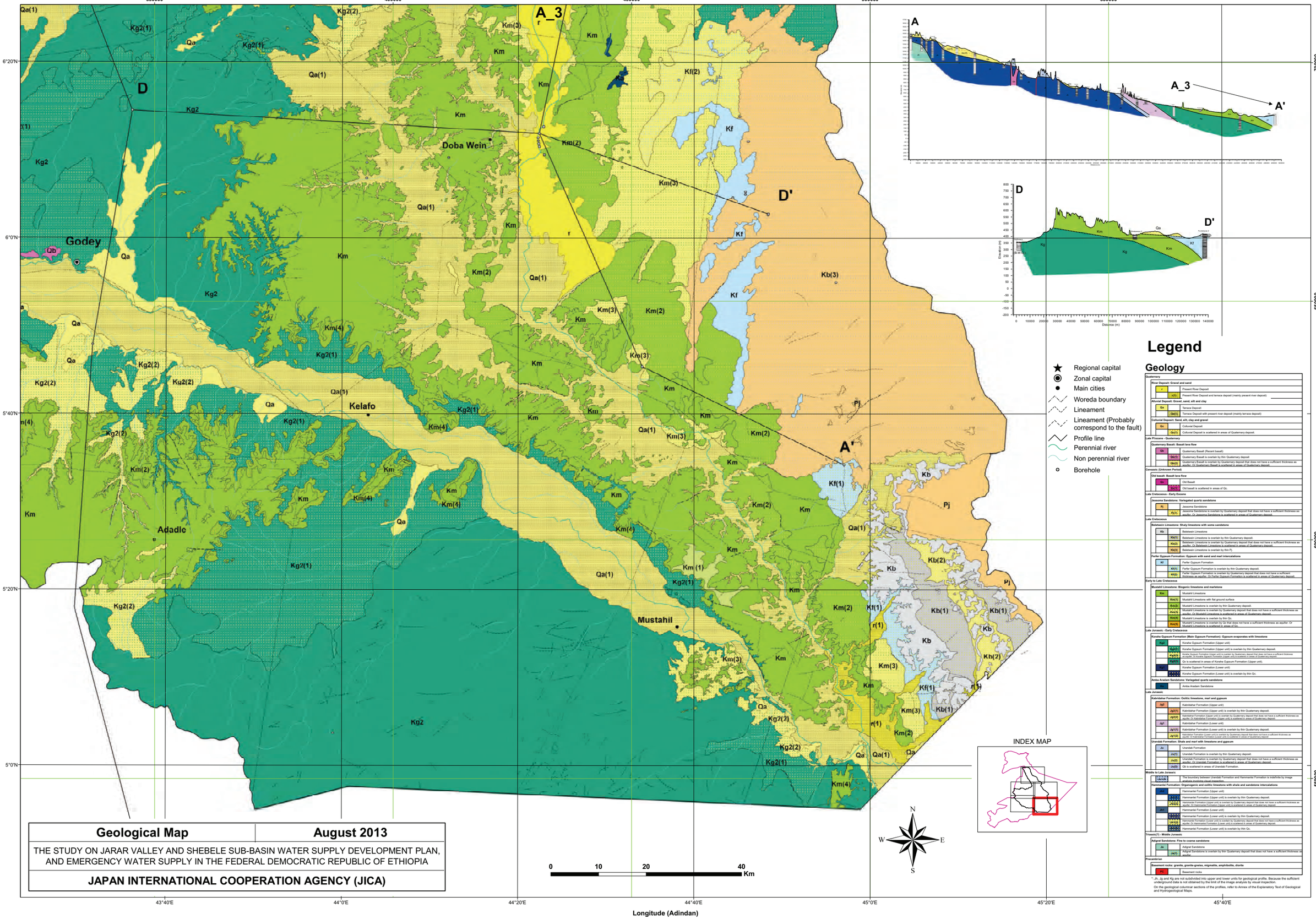
6°20'N 6°0'N 5°40'N 5°20'N 5°0'N

700000 650000 600000 550000

UTM zone 38N Northing

Longitude (Adindan)

43°40'E 44°0'E 44°20'E 44°40'E 45°0'E 45°20'E 45°40'E



Geological Map | **August 2013**

THE STUDY ON JARAR VALLEY AND SHEBELE SUB-BASIN WATER SUPPLY DEVELOPMENT PLAN, AND EMERGENCY WATER SUPPLY IN THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

*: Jh, Jg and Kg are not subdivided into upper and lower units for geological profile. Because the sufficient underground data is not obtained by the limit of the image analysis by visual inspection.
On the geological columnar sections of the profiles, refer to Annex of the Explanatory Text of Geological and Hydrogeological Maps.

UTM zone 38N Easting

100000 200000 300000 400000 500000

1100000 1000000 900000 800000 700000 600000 500000

UTM zone 38N Northing

10° N 9° N 8° N 7° N 6° N 5° N

Latitude (Adindan)

42° E 43° E 44° E 45° E

Longitude (Adindan)

Legend

	Geological Classification	Yield (ℓ/sec.)	Water Quality
	Qa, r	Medium - High : More than 3ℓ/sec.	Excellent - Good : TDS Less than 750 mg/ℓ.
	Ja		
	Qc. Qb, Qv	Low - Medium : 1 - 3 ℓ/sec.	Excellent - Good : TDS Less than 750 mg/ℓ.
	Pj, PC	Poor - Low : Less than 1ℓ/sec.	Excellent - Good : TDS Less than 750 mg/ℓ.
	Km, Jh	Medium - High : More than 3ℓ/sec.	Partly Poor : TDS from 500 - 3,000 mg/ℓ.
	Kb, Ka, Jg	Low - Medium : 1 - 3 ℓ/sec.	Partly Poor : TDS from 500 - 3,000 mg/ℓ.
	Ju	Poor - Low : Less than 1ℓ/sec.	Partly Poor : TDS from 500 - 3,000 mg/ℓ.
	Kg	Low - Medium : 1 - 3 ℓ/sec.	Poor : TDS from 2,500 - 10,000 mg/ℓ.
	Kf	Poor - Low : Less than 1ℓ/sec.	Poor : TDS from 2,500 - 10,000 mg/ℓ.

★ Regional capital ◉ Zonal capital • Main cities Profile line

Woreda boundary Lineament (Probably correspond to the fault)

Perennial river Non perennial river ○ Borehole

On the geological columnar sections of the profiles, refer to Annex of the Explanatory Text of Geological and Hydrogeological Maps.

N W E S

0 25 50 100 Km

Groundwater Utilization Potential Evaluation Map | **August 2013**

THE STUDY ON JARAR VALLEY AND SHEBELE SUB-BASIN WATER SUPPLY DEVELOPMENT PLAN, AND EMERGENCY WATER SUPPLY IN THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

D12-7

UTM zone 38N Easting

200000 250000 300000 350000 400000 450000

UTM zone 38N Northing

1050000 1000000 950000 900000

Latitude (Adindan)

9°20'N 9°0'N 8°40'N 8°20'N 8°0'N

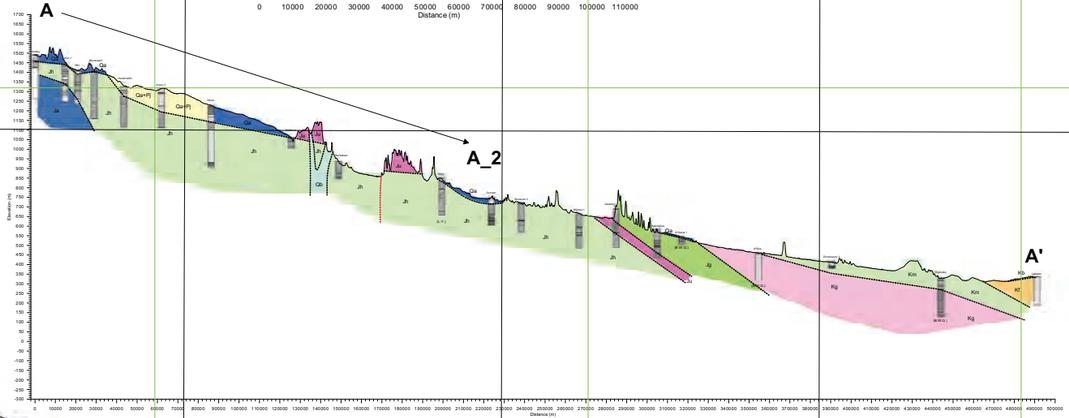
Longitude (Adindan)

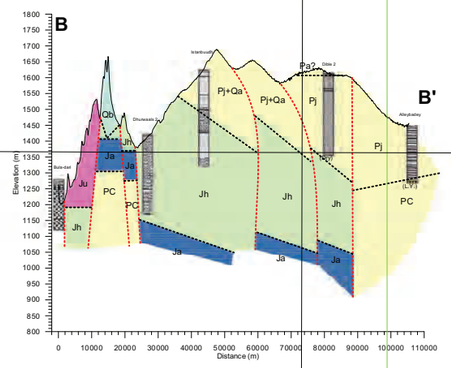
42°20'E 42°40'E 43°0'E 43°20'E 43°40'E 44°0'E 44°20'E

Jijiga
Kebribeyah
Araarso
Dagahbur

Qa, r
Ja
Pj, PC
Kb, Ka, Jg
Ju
Km, Jh
Qc, Qb, Qv

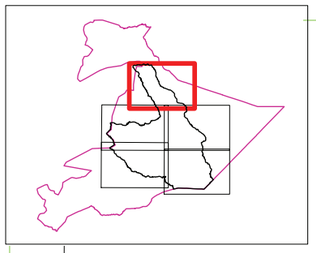
A
A'
A_2
B
B'





N
W E
S

INDEX MAP



0 10 20 40 Km

Legend

	Geological Classification	Yield (ℓ/sec.)	Water Quality
	Qa, r Ja	Medium - High : More than 3ℓ/sec.	Excellent - Good : TDS Less than 750 mg/ℓ.
	Qc. Qb, Qv	Low - Medium : 1 - 3 ℓ/sec.	Excellent - Good : TDS Less than 750 mg/ℓ.
	Pj, PC	Poor - Low : Less than 1ℓ/sec.	Excellent - Good : TDS Less than 750 mg/ℓ.
	Km, Jh	Medium - High : More than 3ℓ/sec.	Partly Poor : TDS from 500 - 3,000 mg/ℓ.
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Regional capital Zonal capital Main cities Profile line
Woreda boundary Lineament (Probably correspond to the fault)
Perennial river Non perennial river Borehole

On the geological columnar sections of the profiles, refer to Annex of the Explanatory Text of Geological and Hydrogeological Maps.

Groundwater Utilization Potential Evaluation Map | **August 2013**

THE STUDY ON JARAR VALLEY AND SHEBELE SUB-BASIN WATER SUPPLY DEVELOPMENT PLAN, AND EMERGENCY WATER SUPPLY IN THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Groundwater Utilization Potential Evaluation Map

August 2013

THE STUDY ON JARAR VALLEY AND SHEBELE SUB-BASIN WATER SUPPLY DEVELOPMENT PLAN, AND EMERGENCY WATER SUPPLY IN THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

UTM zone 38N Easting: 100000, 150000, 200000, 250000, 300000

UTM zone 38N Northing: 900000, 850000, 800000, 750000

Latitude (Adindan): 8°0'N, 7°40'N, 7°20'N, 7°0'N, 6°40'N

Longitude (Adindan): 41°0'E, 41°20'E, 41°40'E, 42°0'E, 42°20'E, 42°40'E, 43°0'E, 43°20'E

0 10 20 40 Km

N W E S

Legend

	Geological Classification	Yield (ℓ/sec.)	Water Quality
	Qa, r	Medium - High : More than 3ℓ/sec.	Excellent - Good : TDS Less than 750 mg/ℓ.
	Ja		
	Qc. Qb, Qv	Low - Medium : 1 - 3 ℓ/sec.	Excellent - Good : TDS Less than 750 mg/ℓ.
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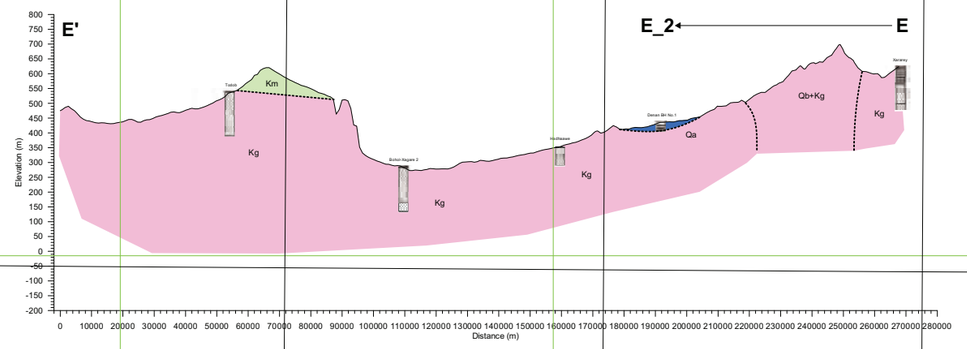
★ Regional capital ◉ Zonal capital ● Main cities Profile line

Woreda boundary Lineament (Probably correspond to the fault)

Perennial river Non perennial river Borehole

On the geological columnar sections of the profiles, refer to Annex of the Explanatory Text of Geological and Hydrogeological Maps.



INDEX MAP

D1.2-9

UTM zone 38N Easting

350000 400000 450000 500000 550000

8°0'N
7°40'N
7°20'N
7°0'N
6°40'N

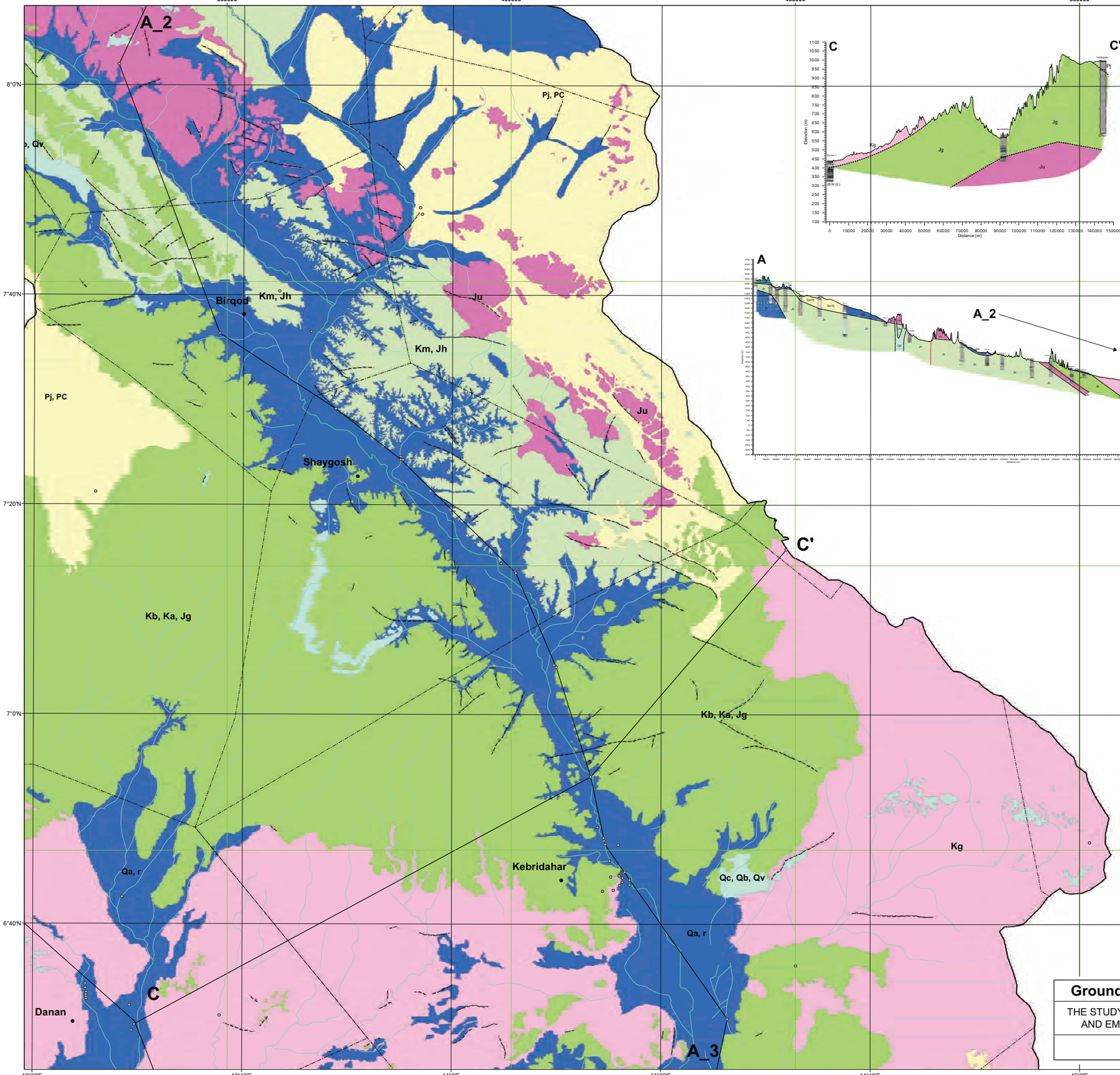
Latitude (Adindan)

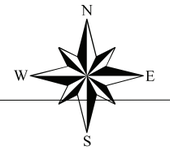
43°20'E 43°40'E 44°0'E 44°20'E 44°40'E 45°0'E 45°20'E 45°40'E

Longitude (Adindan)

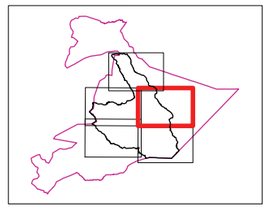
850000 800000 750000

UTM zone 38N Northing





INDEX MAP



Legend

	Geological Classification	Yield (ℓ/sec.)	Water Quality
	Qa, r	Medium - High : More than 3ℓ/sec.	Excellent - Good : TDS Less than 750 mg/ℓ.
	Ja		
	Qc. Qb, Qv	Low - Medium : 1 - 3 ℓ/sec.	Excellent - Good : TDS Less than 750 mg/ℓ.
	Pj, PC	Poor - Low : Less than 1ℓ/sec.	Excellent - Good : TDS Less than 750 mg/ℓ.
	Km, Jh	Medium - High : More than 3ℓ/sec.	Partly Poor : TDS from 500 - 3,000 mg/ℓ.
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	Kf	Poor - Low : Less than 1ℓ/sec.	Poor : TDS from 2,500 - 10,000 mg/ℓ.

★ Regional capital ◉ Zonal capital ● Main cities Profile line

Woreda boundary Lineament (Probably correspond to the fault)

Perennial river Non perennial river Borehole

On the geological columnar sections of the profiles, refer to Annex of the Explanatory Text of Geological and Hydrogeological Maps.

0 10 20 40 Km

Groundwater Utilization Potential Evaluation Map | **August 2013**

THE STUDY ON JARAR VALLEY AND SHEBELE SUB-BASIN WATER SUPPLY DEVELOPMENT PLAN, AND EMERGENCY WATER SUPPLY IN THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

UTM zone 38N Easting

100000 150000 200000 250000 300000 350000

Latitude (Adindan)

6°20'N 6°0'N 5°40'N 5°20'N 5°0'N

UTM zone 38N Northing

700000 650000 600000 550000

41°40'E 42°0'E 42°20'E 42°40'E 43°0'E 43°20'E 43°40'E

Longitude (Adindan)

Rasso
East Ime
West Ime
Beercaarno
Danan
Godey
Adadle
Kb, Ka, Jg
Kg
Qa, r
Ja
E'
E
E_2
E_3
C
D

N
W
E
S

INDEX MAP

Legend

	Geological Classification	Yield (ℓ/sec.)	Water Quality
	Qa, r	Medium - High : More than 3ℓ/sec.	Excellent - Good : TDS Less than 750 mg/ℓ.
	Ja		
	Qc. Qb, Qv	Low - Medium : 1 - 3 ℓ/sec.	Excellent - Good : TDS Less than 750 mg/ℓ.
	Pj, PC	Poor - Low : Less than 1ℓ/sec.	Excellent - Good : TDS Less than 750 mg/ℓ.
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	Kb, Ka, Jg	Low - Medium : 1 - 3 ℓ/sec.	Partly Poor : TDS from 500 - 3,000 mg/ℓ.
	Ju	Poor - Low : Less than 1ℓ/sec.	Partly Poor : TDS from 500 - 3,000 mg/ℓ.
	Kg	Low - Medium : 1 - 3 ℓ/sec.	Poor : TDS from 2,500 - 10,000 mg/ℓ.
	Kf	Poor - Low : Less than 1ℓ/sec.	Poor : TDS from 2,500 - 10,000 mg/ℓ.

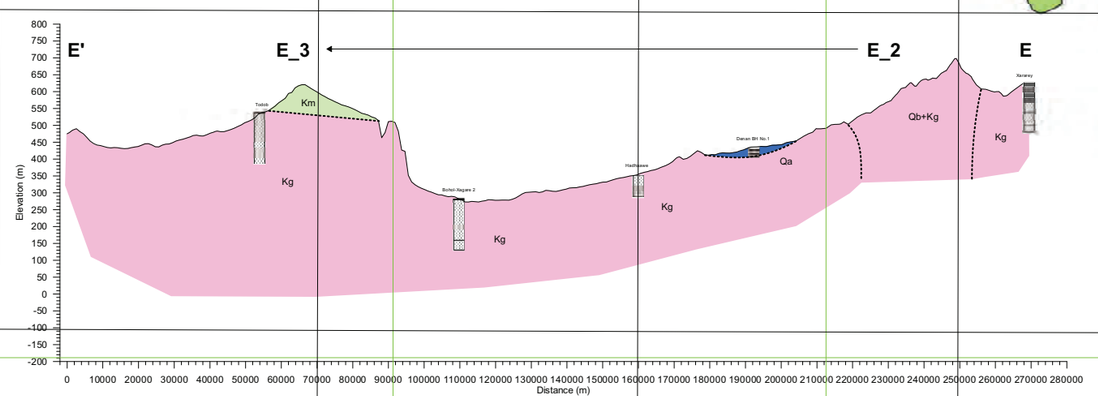
Regional capital · Zonal capital · Main cities · Profile line

Woreda boundary · Lineament (Probably correspond to the fault)

Perennial river · Non perennial river · Borehole

On the geological columnar sections of the profiles, refer to Annex of the Explanatory Text of Geological and Hydrogeological Maps.

0 10 20 40 Km



Groundwater Utilization Potential Evaluation Map | **August 2013**

THE STUDY ON JARAR VALLEY AND SHEBELE SUB-BASIN WATER SUPPLY DEVELOPMENT PLAN, AND EMERGENCY WATER SUPPLY IN THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

UTM zone 38N Easting

350000 400000 450000 500000 550000

6°20'N 6°0'N 5°40'N 5°20'N 5°0'N

700000 650000 600000 550000

Latitude (Adindan) — UTM zone 38N Northing

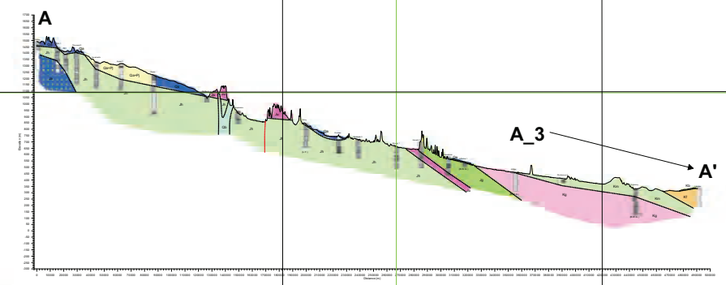
43°40'E 44°0'E 44°20'E 44°40'E 45°0'E 45°20'E 45°40'E

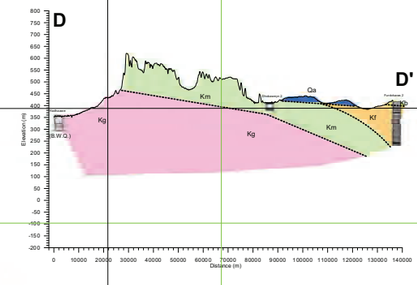
Longitude (Adindan)

A_3 D D' A A'

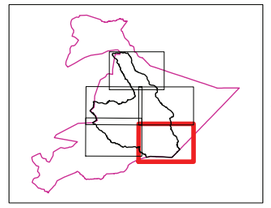
Kg Qa, r Kb, Ka, Jg Kf Pj, PC Km, Jh Ju Qc. Qb, Qv

Godey Doba Wein Kelafo Adadle Mustahil





INDEX MAP



N W E S

0 10 20 40 Km

Legend

	Geological Classification	Yield (ℓ/sec.)	Water Quality
	Qa, r	Medium - High : More than 3ℓ/sec.	Excellent - Good : TDS Less than 750 mg/ℓ.
	Ja		
	Qc. Qb, Qv	Low - Medium : 1 - 3 ℓ/sec.	Excellent - Good : TDS Less than 750 mg/ℓ.
	Pj, PC	Poor - Low : Less than 1ℓ/sec.	Excellent - Good : TDS Less than 750 mg/ℓ.
	Km, Jh	Medium - High : More than 3ℓ/sec.	Partly Poor : TDS from 500 - 3,000 mg/ℓ.
	Kb, Ka, Jg	Low - Medium : 1 - 3 ℓ/sec.	Partly Poor : TDS from 500 - 3,000 mg/ℓ.
	Ju	Poor - Low : Less than 1ℓ/sec.	Partly Poor : TDS from 500 - 3,000 mg/ℓ.
	Kg	Low - Medium : 1 - 3 ℓ/sec.	Poor : TDS from 2,500 - 10,000 mg/ℓ.
	Kf	Poor - Low : Less than 1ℓ/sec.	Poor : TDS from 2,500 - 10,000 mg/ℓ.

Regional capital Zonal capital Main cities Profile line

Woreda boundary Lineament (Probably correspond to the fault)

Perennial river Non perennial river Borehole

On the geological columnar sections of the profiles, refer to Annex of the Explanatory Text of Geological and Hydrogeological Maps.

Groundwater Utilization Potential Evaluation Map | August 2013

THE STUDY ON JARAR VALLEY AND SHEBELE SUB-BASIN WATER SUPPLY DEVELOPMENT PLAN, AND EMERGENCY WATER SUPPLY IN THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

UTM zone 38N Easting

-300000 -200000 -100000 0 100000 200000 300000 400000 500000 600000 700000 800000 900000

N W E S

11° N 10° N 9° N 8° N 7° N 6° N 5° N 4° N 3° N

1200000 1100000 1000000 900000 800000 700000 600000 500000 400000 300000

UTM zone 38N Northing

Latitude (Adindan)

Area with high possibility of shallow groundwater level

- Rank 1 (Area around perennial river)
- Rnak 2 (Area around non perennial river)
- Rank 3 (Area with slope steep in mountain side and gentle in plain side)

Groundwater potential classification

- High
- Relatively high
- Middle
- Relatively low
- Low

Water Quality

- Excellent water quality with TDS rarely exceeding 750mg/l.
- TDS < 500 mg/l
- Good water quality with TDS ranges from 500 - 2000 mg/l.
- Water quality is generally good. TDS ranging from 500 - 3000mg/l.
- Extremely variable water quality with TDS ranges from 500 - 5000mg/l.
- Generally poor water quality with TDS exceeding 2500mg/l.

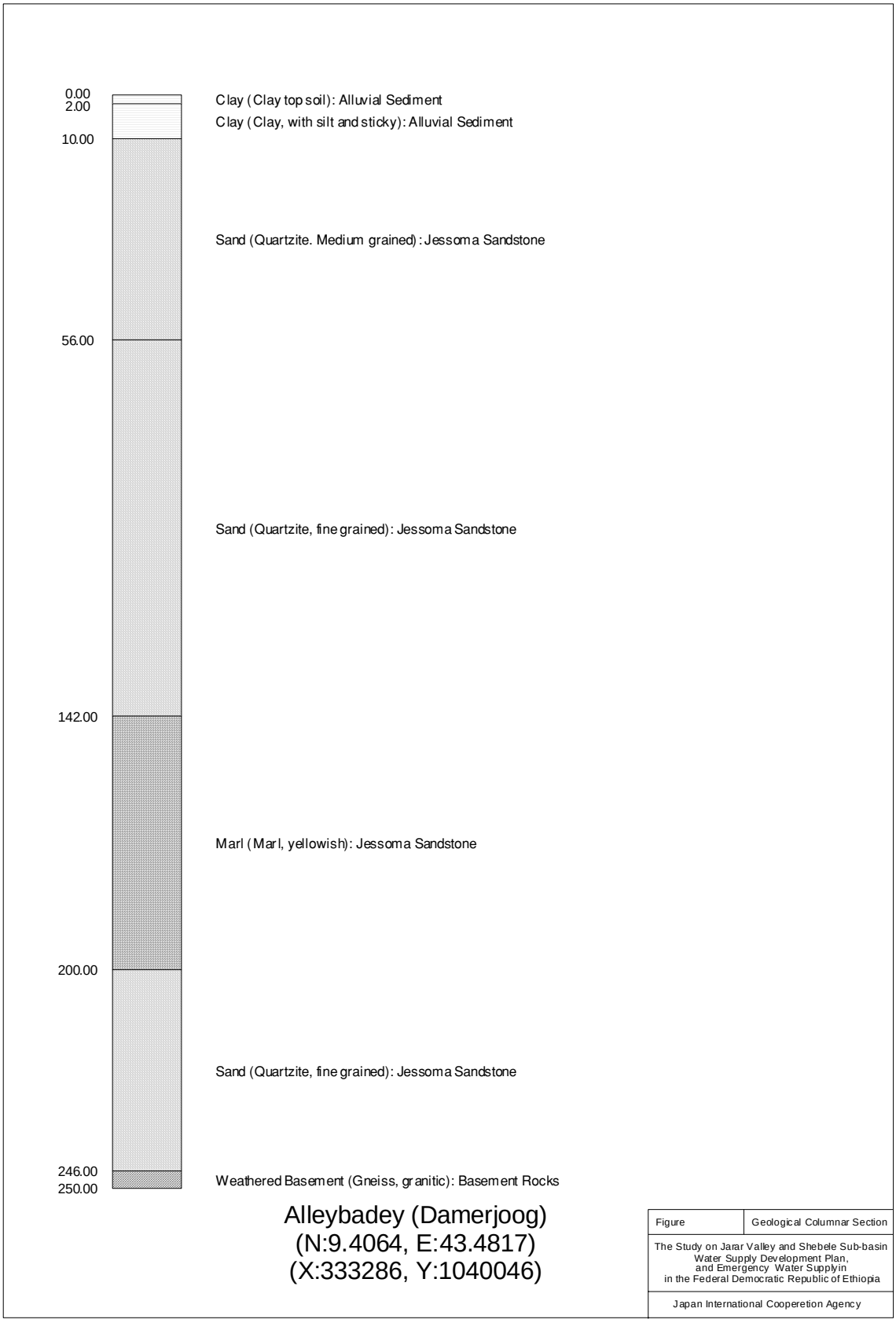
0 50 100 200 300 Km

38° E 39° E 40° E 41° E 42° E 43° E 44° E 45° E 46° E 47° E 48° E 49° E

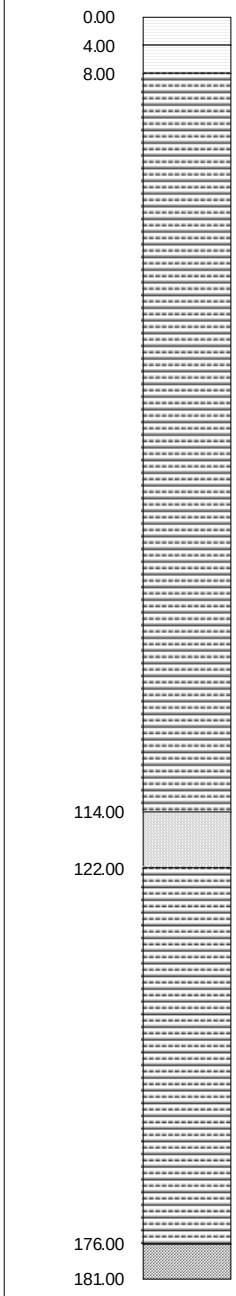
Longitude (Adindan)

Water Resources Information Map	August 2013
THE STUDY ON JARAR VALLEY AND SHEBELE SUB-BASIN WATER SUPPLY DEVELOPMENT PLAN, AND EMERGENCY WATER SUPPLY IN THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	

Data 1.2.4 : Geological Columnar Section for Somali Region (1/41)



Data 1.2.4 : Geological Columnar Section for Somali Region (2/41)



Clay (Dark clay) : Alluvial Sediment

Clay (Reddish clay with sand): Alluvial Sediment

Clay/Sand (Fine Sand with reddish clay): Jessoma Sandstone

Sand (Reddish loose sand) : Jessoma Sandstone

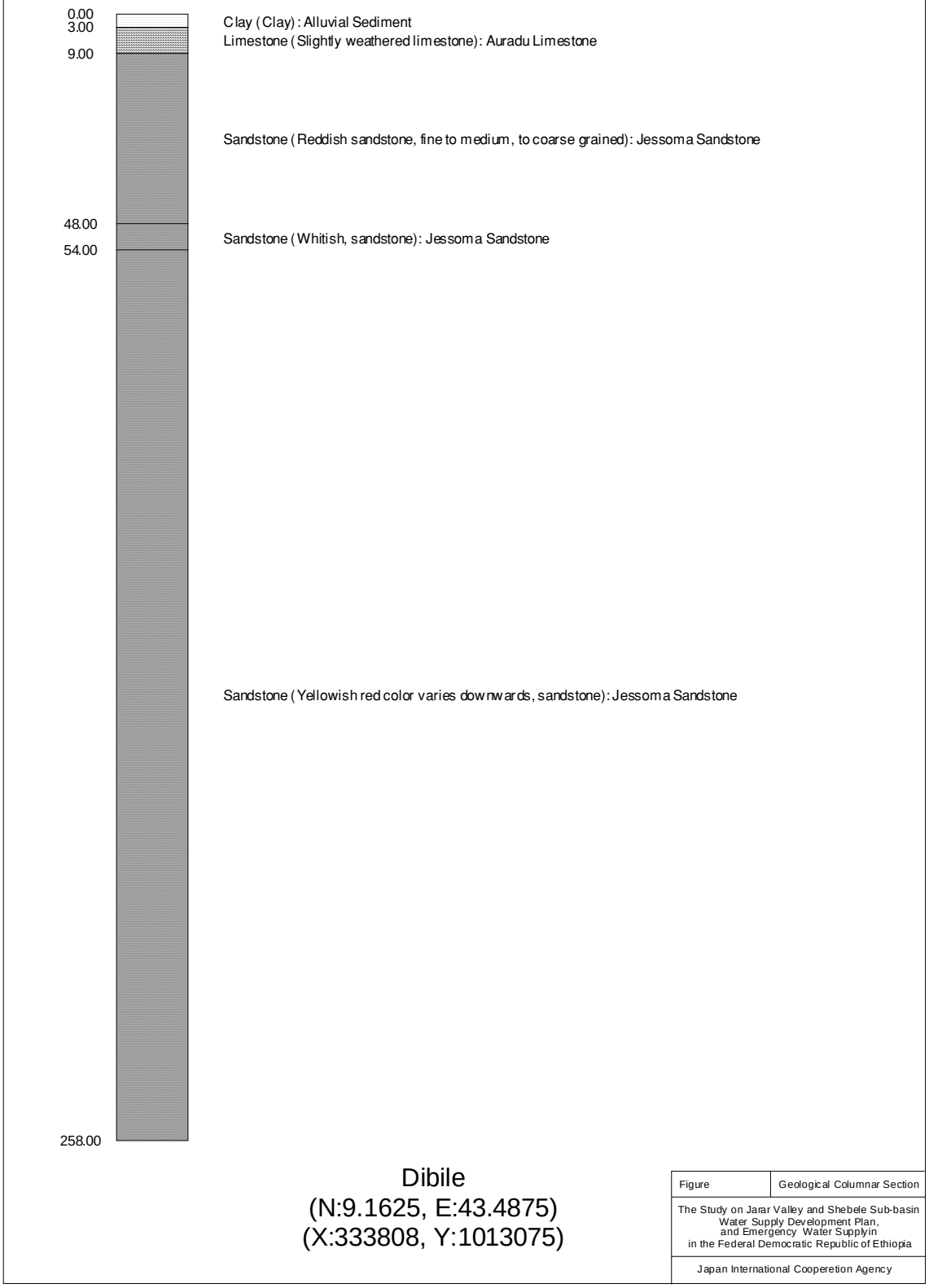
Clay/Sand (Reddish medium to red sand with clay): Jessoma Sandstone

Weathered Basement (Weathered Basement) : Basement Rocks

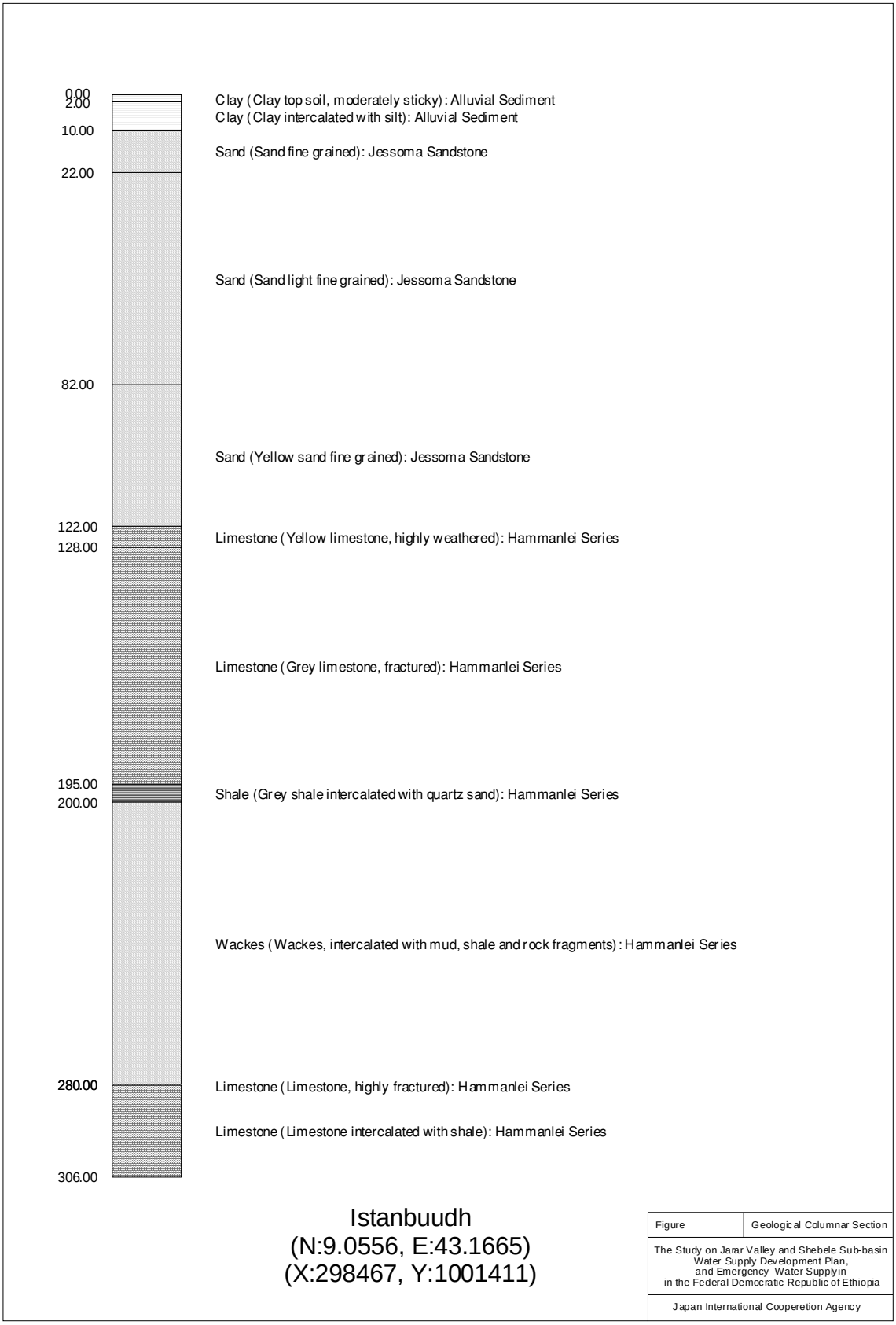
Alleybadey (2)
(N:9.3853, E:43.5231)
(X:337823, Y:1037695)

Figure	Geological Columnar Section
The Study on Jarar Valley and Shebele Sub-basin Water Supply Development Plan, and Emergency Water Supplyin in the Federal Democratic Republic of Ethiopia	
Japan International Cooperetion Agency	

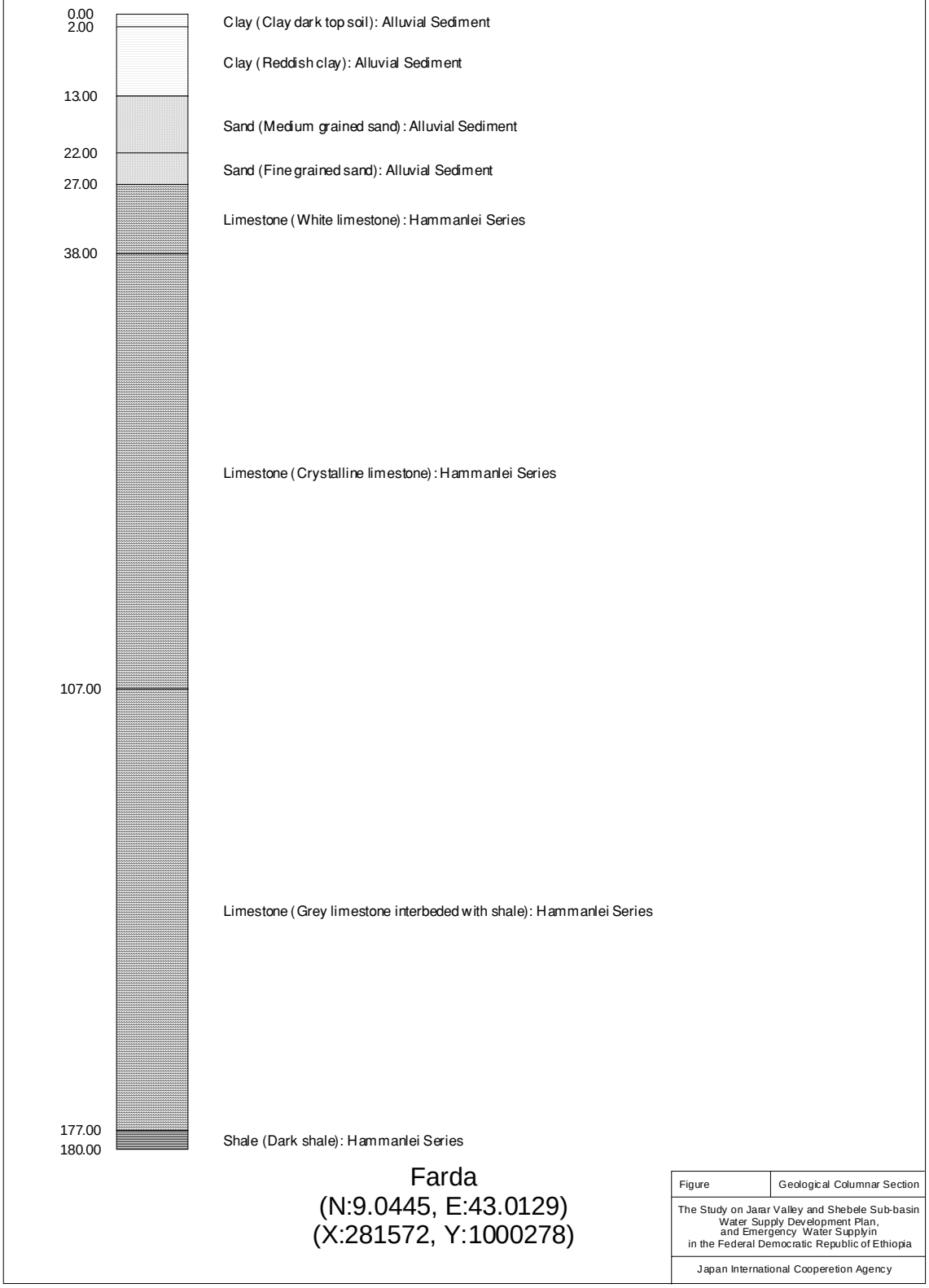
Data 1.2.4 : Geological Columnar Section for Somali Region (3/41)



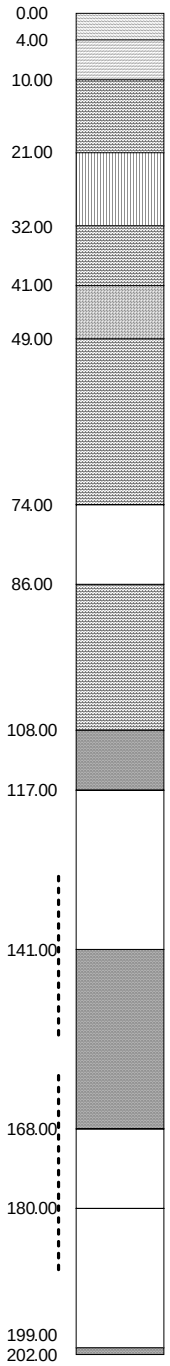
Data 1.2.4 : Geological Columnar Section for Somali Region (4/41)



Data 1.2.4 : Geological Columnar Section for Somali Region (5/41)



Data 1.2.4 : Geological Columnar Section for Somali Region (6/41)



Top soil (Black color, sandy clay) : Alluvial Sediment

Sandy clay (Medium to coarse grained, brownish color): Alluvial Sediment

Limestone (Brownish medium to coarse grained): Alluvial Sediment

Transition between top soil & limestone (Brownish color, moderately fractured and weathered): Alluvial Sediment

Limestone (Whitish brownish color, highly fractured and moderately weathered coarse grained): Hammanlei Series

Marly Limestone (Whitish color fine grained): Hammanlei Series

Limestone (Highly fractured slightly weathered coarse grained, whitish color): Hammanlei Series

No sample (Leakage of muddy water of circulation about silty or clay sediment)

Limestone (86-93m: medium to coarse sand, 93-100m: fine sand, 100-108m: medium): Hammanlei Series

Sandstone (108-113m: dark gray, 113-114m: fractured gravel, water strike, yellow color gravel & pebbles, 114-117m: dark gray very coarse sand): Adigrat Sandstone

No sample

Sandstone (141-142m: light brown fine-medium sandstone, 142-168m: dark gray medium-coarse sandstone): Adigrat Sandstone

No sample (Probably, the sandstone layer continues)

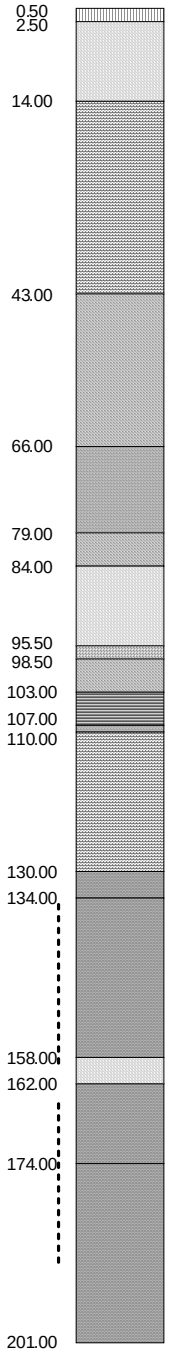
No sample (Probably, the sandstone layer continues)

Sandstone (Grain to gravel size, light grey): Adigrat Sandstone

JICA No-1
(N:9.0436, E:43.0087)
(X:281111, Y:1000180)

Figure	Geological Columnar Section
The Study on Jarar Valley and Shebele Sub-basin Water Supply Development Plan, and Emergency Water Supplyin in the Federal Democratic Republic of Ethiopia	
Japan International Cooperetion Agency	

Data 1.2.4 : Geological Columnar Section for Somali Region (7/41)



Top soil: Alluvial Sediment

Sand (2-9m: light brown to white brown, fine-very fine sand (weathering limestone zone), 9-14m: red brown, fine-medium sand (weathering limestone zone)): Alluvial Sediment

Slightly weathered limestone and medium to grained limestone zone (14-23m: white brown color, 23-29m: yellow brown color, 29-30m: white color, 30-37m: yellow brown color, 37-43m: white brown color): Hammanlei Series

Alternation of marl, sand and limestone (Medium to grained): Hammanlei Series

Light yellow, grained and coarse sandy limestone (There are weathered and fractured in some segment): Hammanlei Series

Marly sand (Yellowish): Hammanlei Series

Coarse sand (Highly fractured and weathered limestone zone): Hammanlei Series

Marl: Hammanlei Series
Alternation of marl, sand and limestone (medium to coarse): Hammanlei Series

Sedimentary layers of shale (Dark green gray): Hammanlei Series
Sandy limestone: Hammanlei Series

Massive limestone (Dark green gray): Hammanlei Series

Sandstone (Alternation of very fine to fine and coarse sandstone, with fractured sandstone, dark green gray to dark gray): Adigrat Sandstone

Sandstone (134-141m: fine sandstone, dark green gray, 141-143m: coarse sandstone, dark green gray, 143-147m: fine sandstone, yellow gray, 147-158m: very fine sandstone, light gray): Adigrat Sandstone

Sand (Very fine sand, yellow gray): Adigrat Sandstone

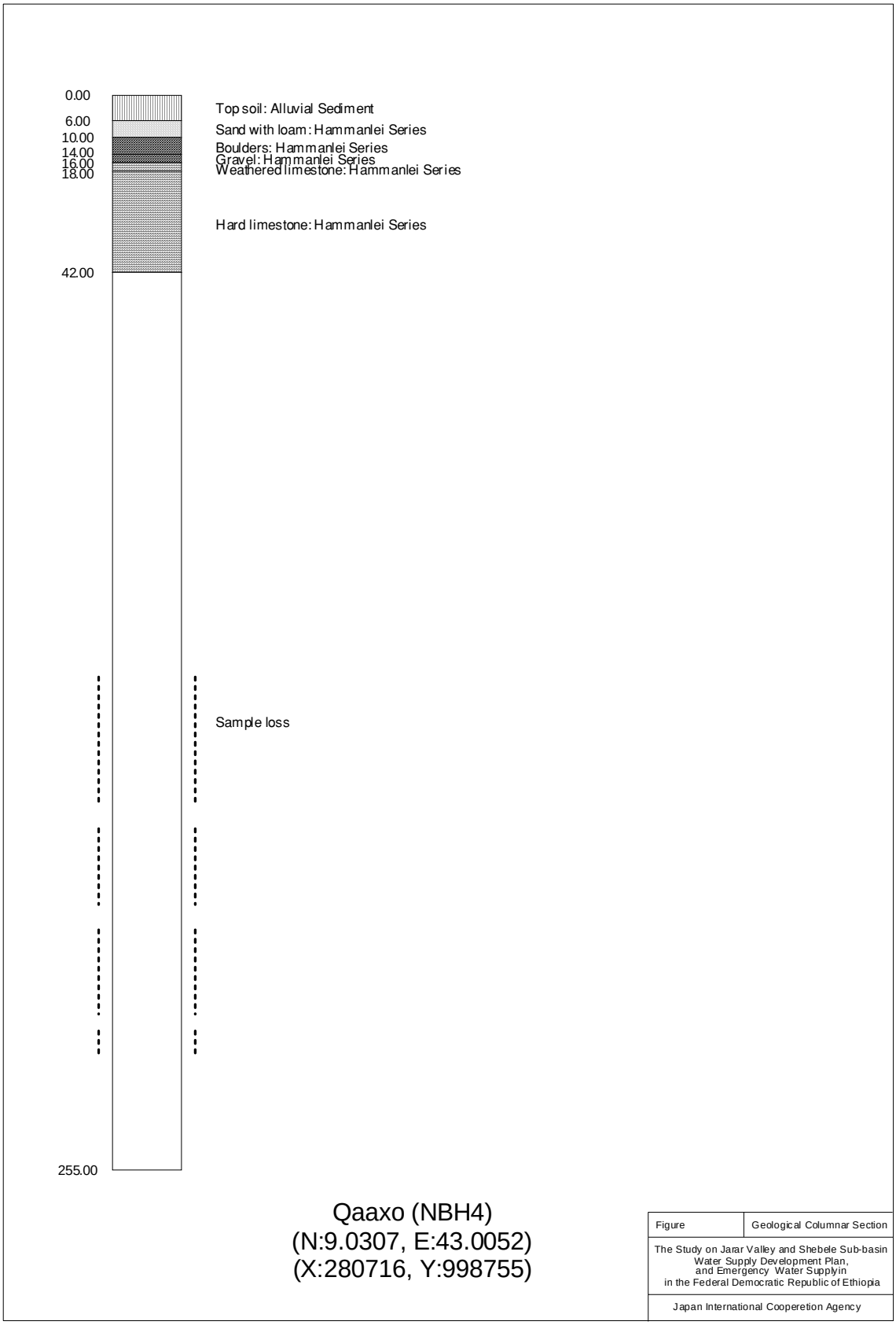
Sandstone (Medium sandstone, dark gray): Adigrat Sandstone

Sandstone (174-177m: coarse sandstone (dark gray), 177-197m: fine sandstone (gray), 197-201m: medium sandstone (dark gray)): Adigrat Sandstone

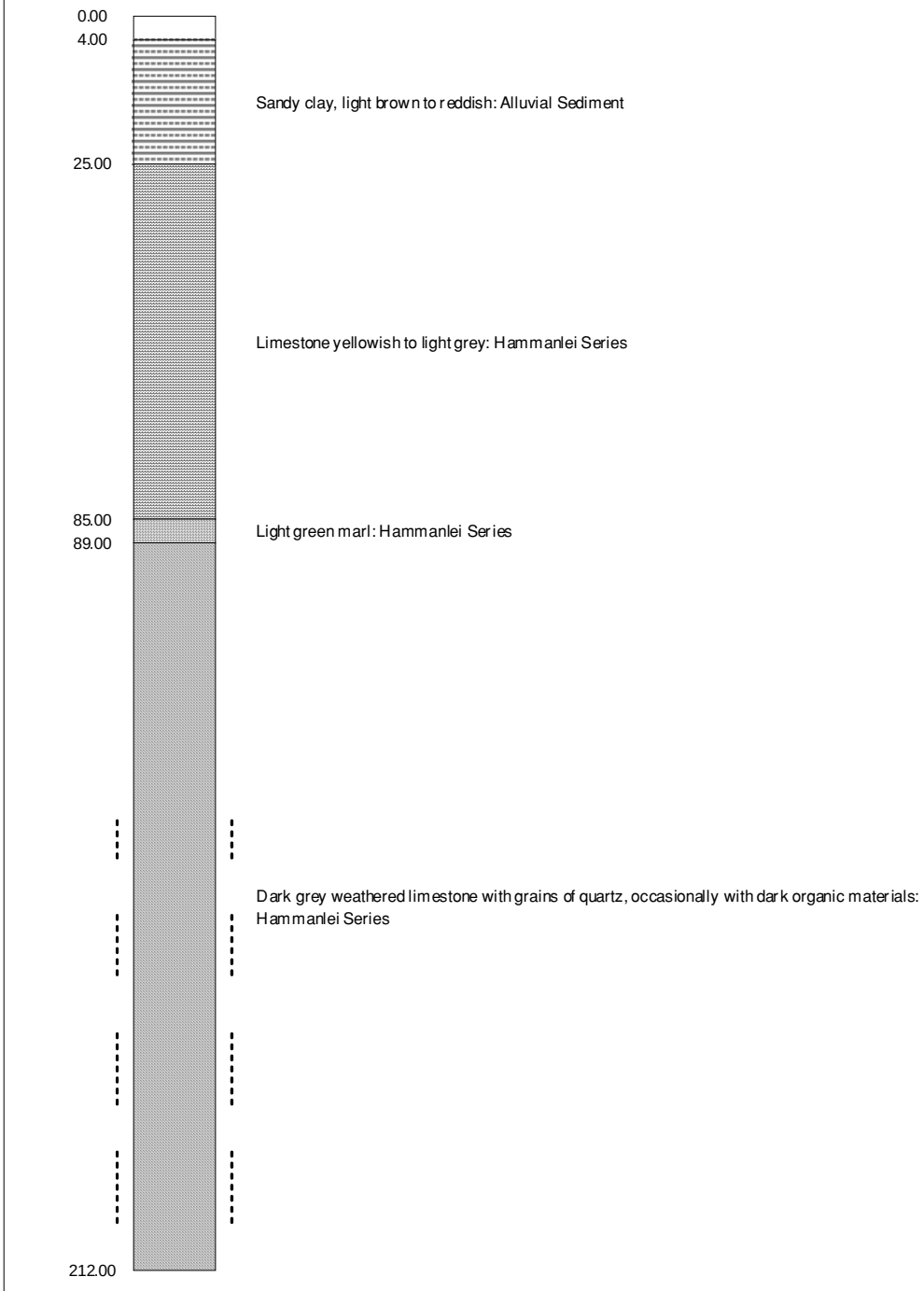
JICA No-2
(N:9.0420, E:43.0054)
(X:280743, Y:1000004)

Figure	Geological Columnar Section
The Study on Jarar Valley and Shebele Sub-basin Water Supply Development Plan, and Emergency Water Supplyin in the Federal Democratic Republic of Ethiopia	
Japan International Cooperetion Agency	

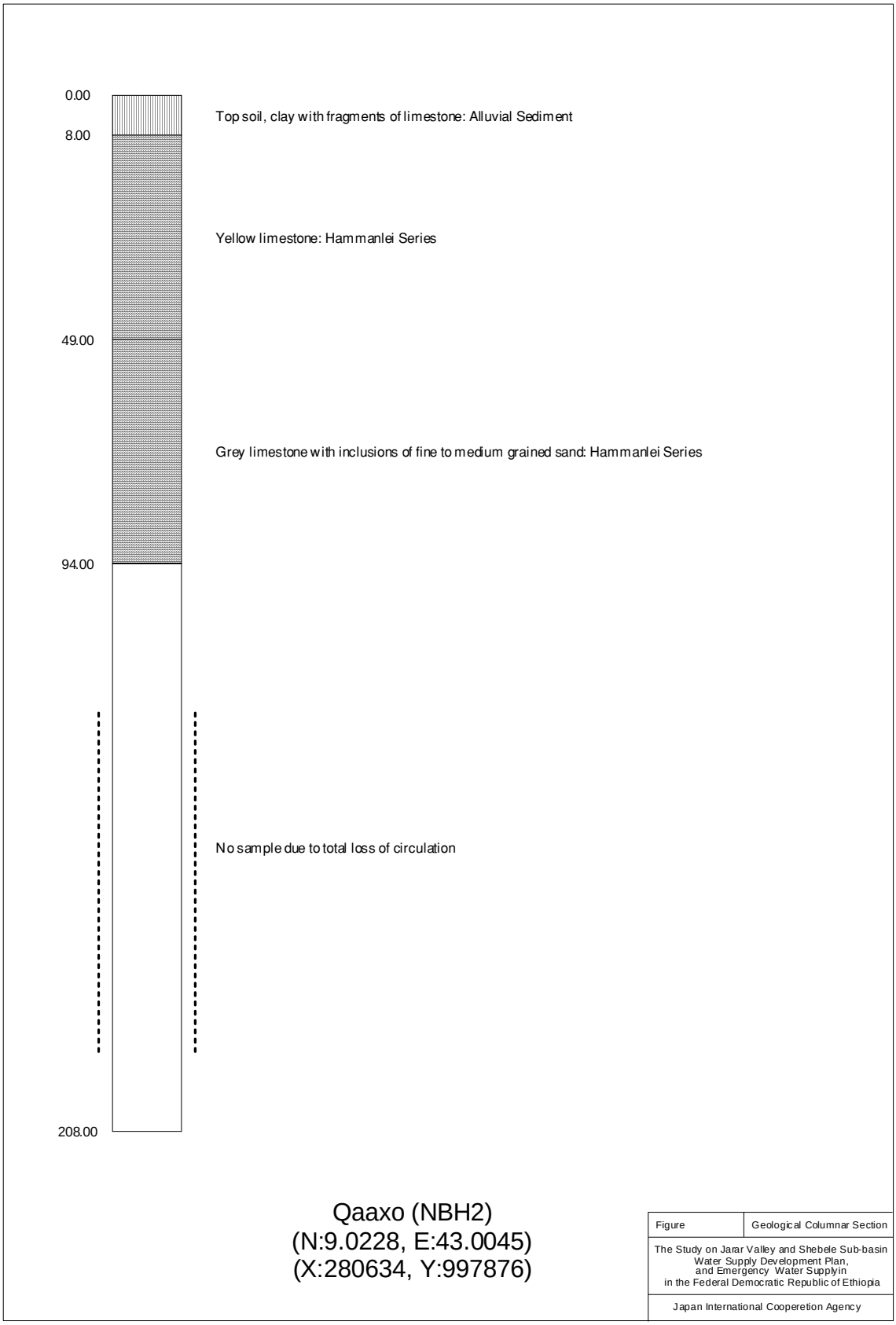
Data 1.2.4 : Geological Columnar Section for Somali Region (8/41)



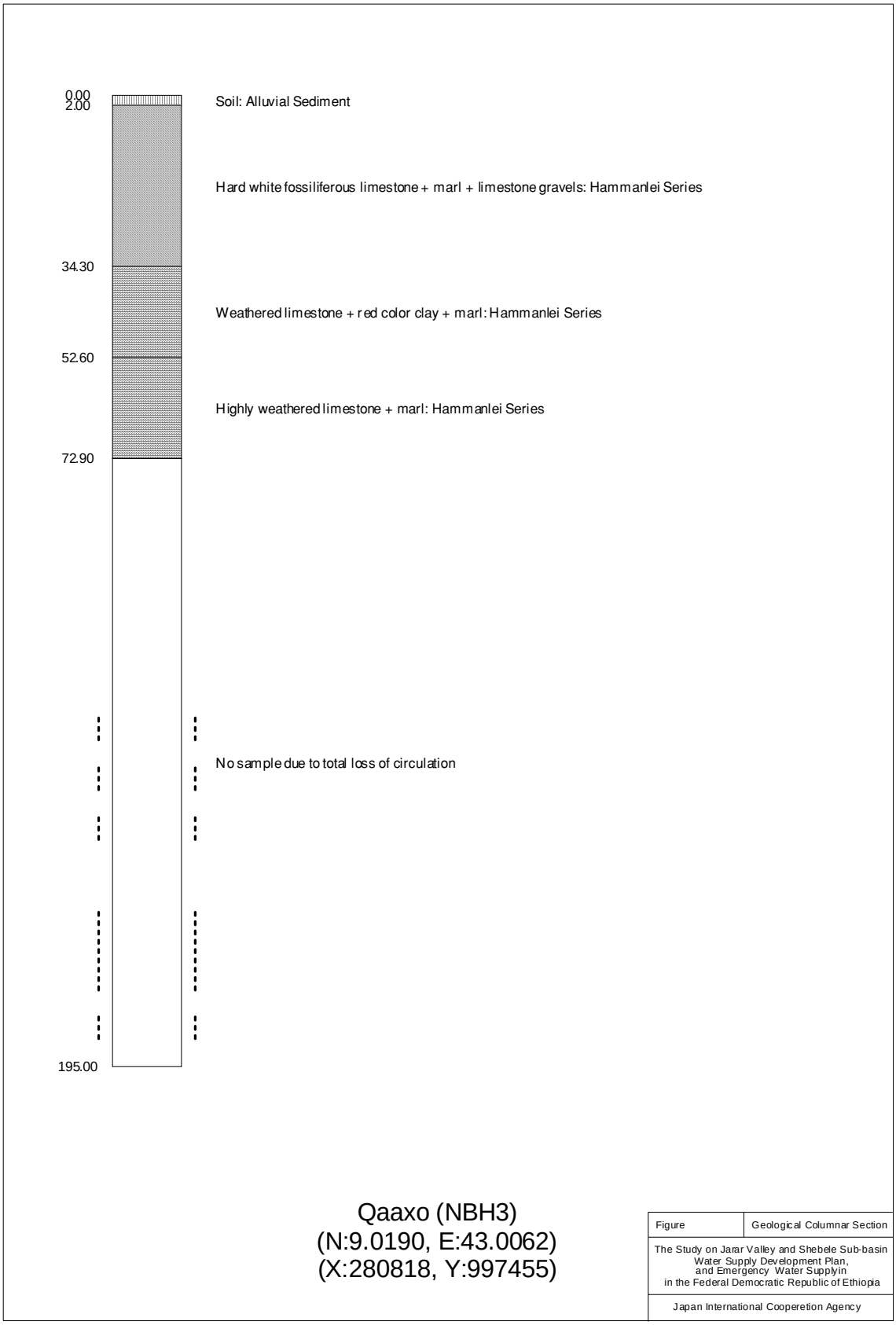
Data 1.2.4 : Geological Columnar Section for Somali Region (9/41)



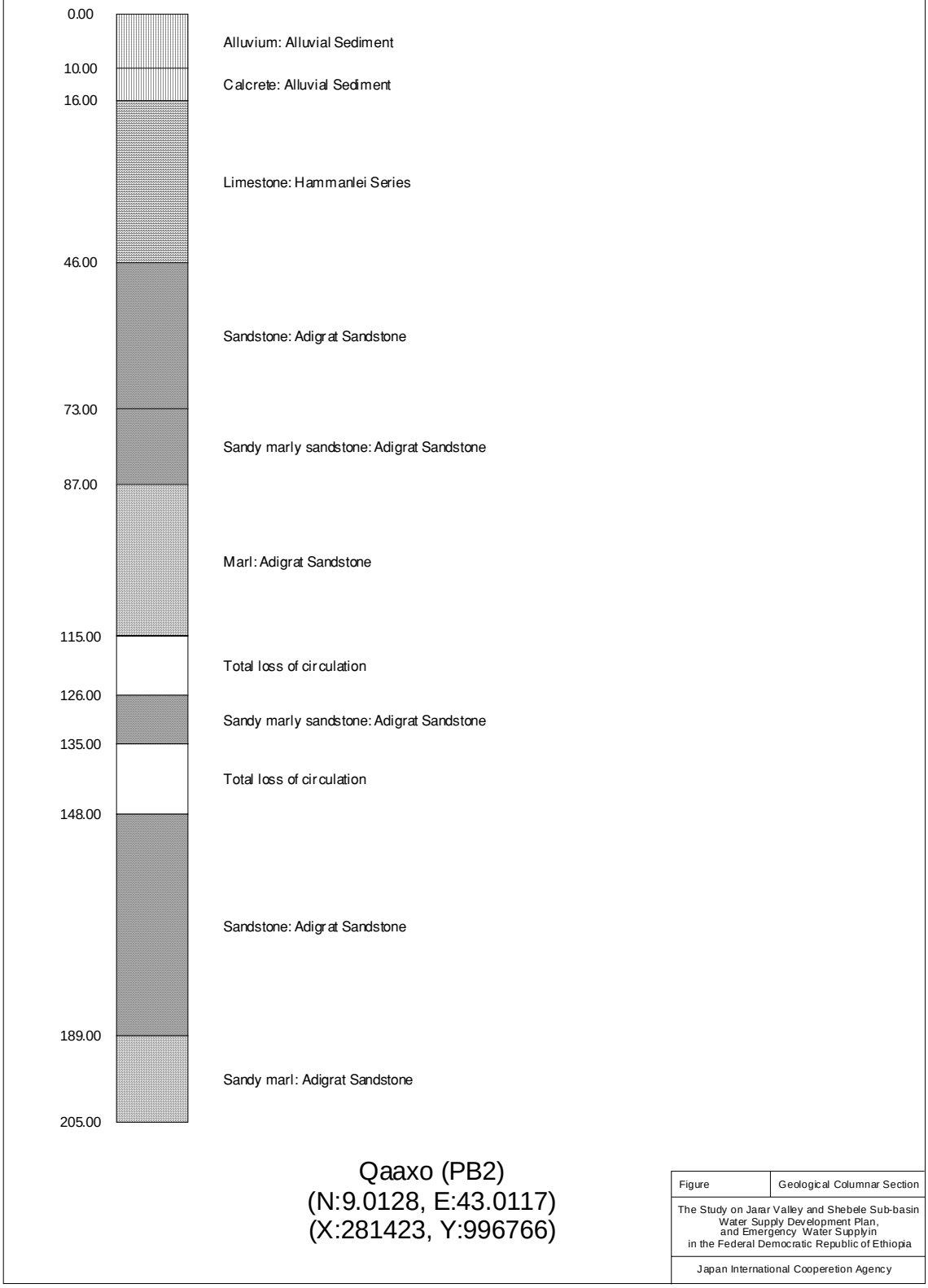
Data 1.2.4 : Geological Columnar Section for Somali Region (10/41)



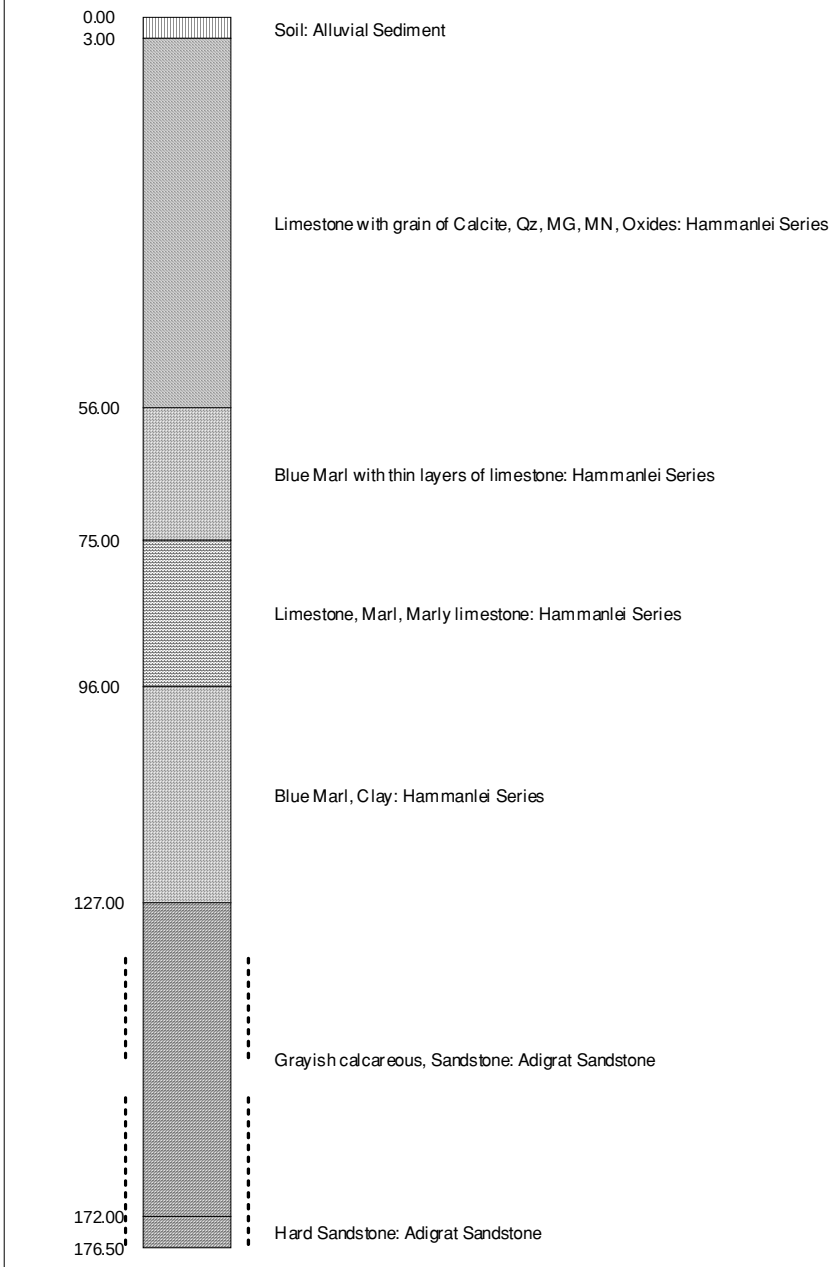
Data 1.2.4 : Geological Columnar Section for Somali Region (11/41)



Data 1.2.4 : Geological Columnar Section for Somali Region (12/41)



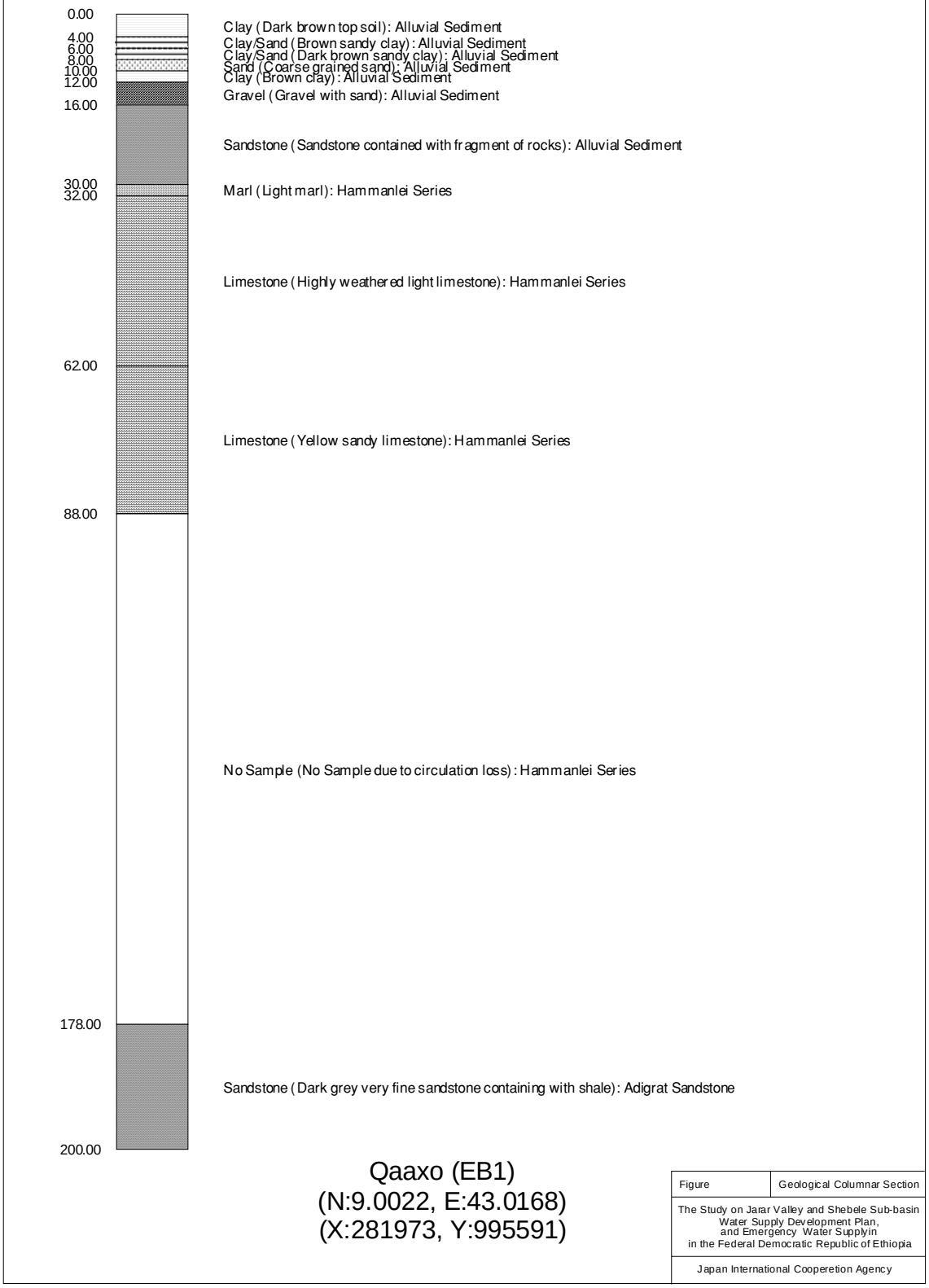
Data 1.2.4 : Geological Columnar Section for Somali Region (13/41)



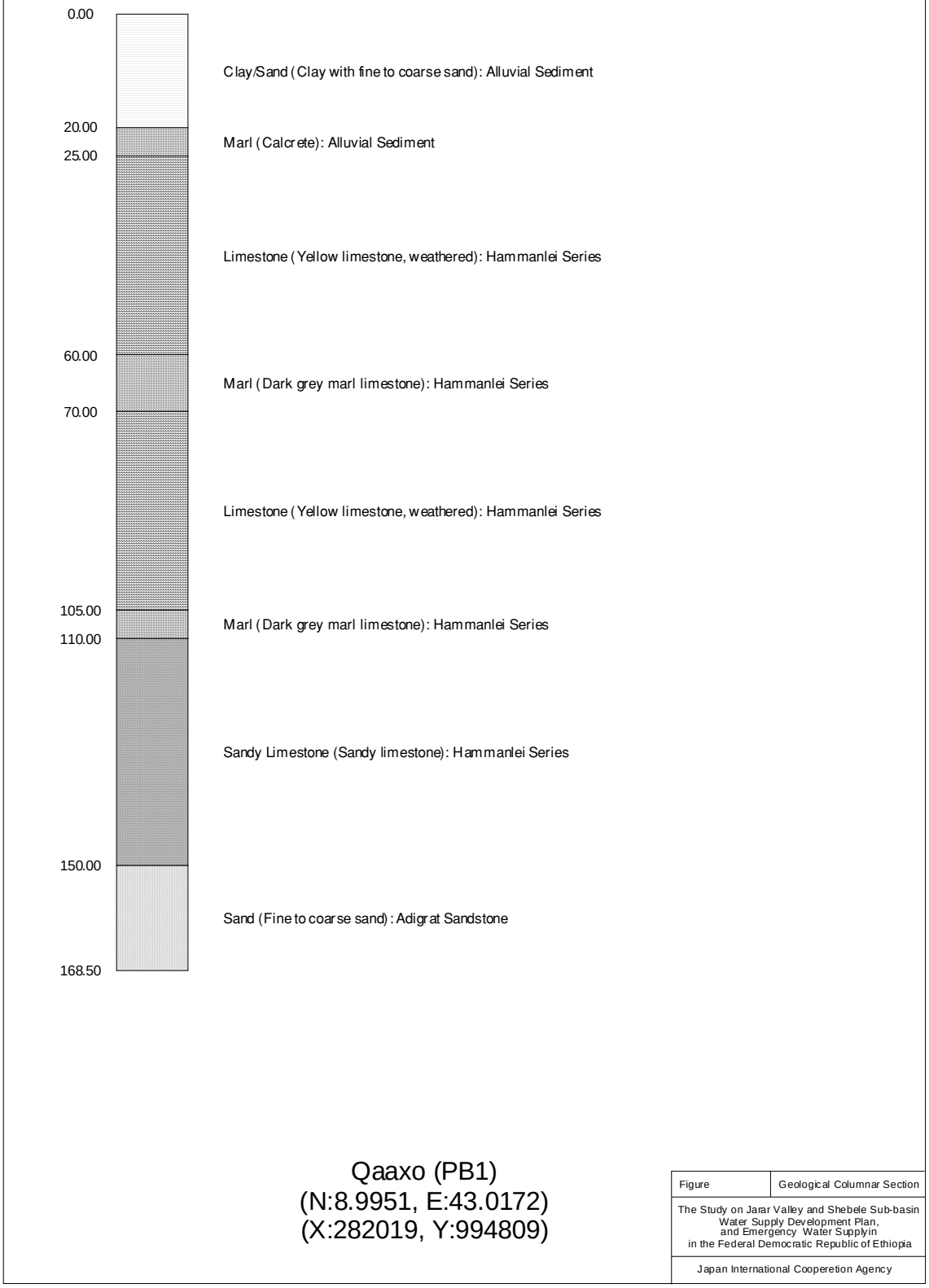
Qaaxo (EB2)
(N:9.0073, E:43.0159)
(X:281874, Y:996159)

Figure	Geological Columnar Section
The Study on Jarar Valley and Shebele Sub-basin Water Supply Development Plan, and Emergency Water Supplyin in the Federal Democratic Republic of Ethiopia	
Japan International Cooperetion Agency	

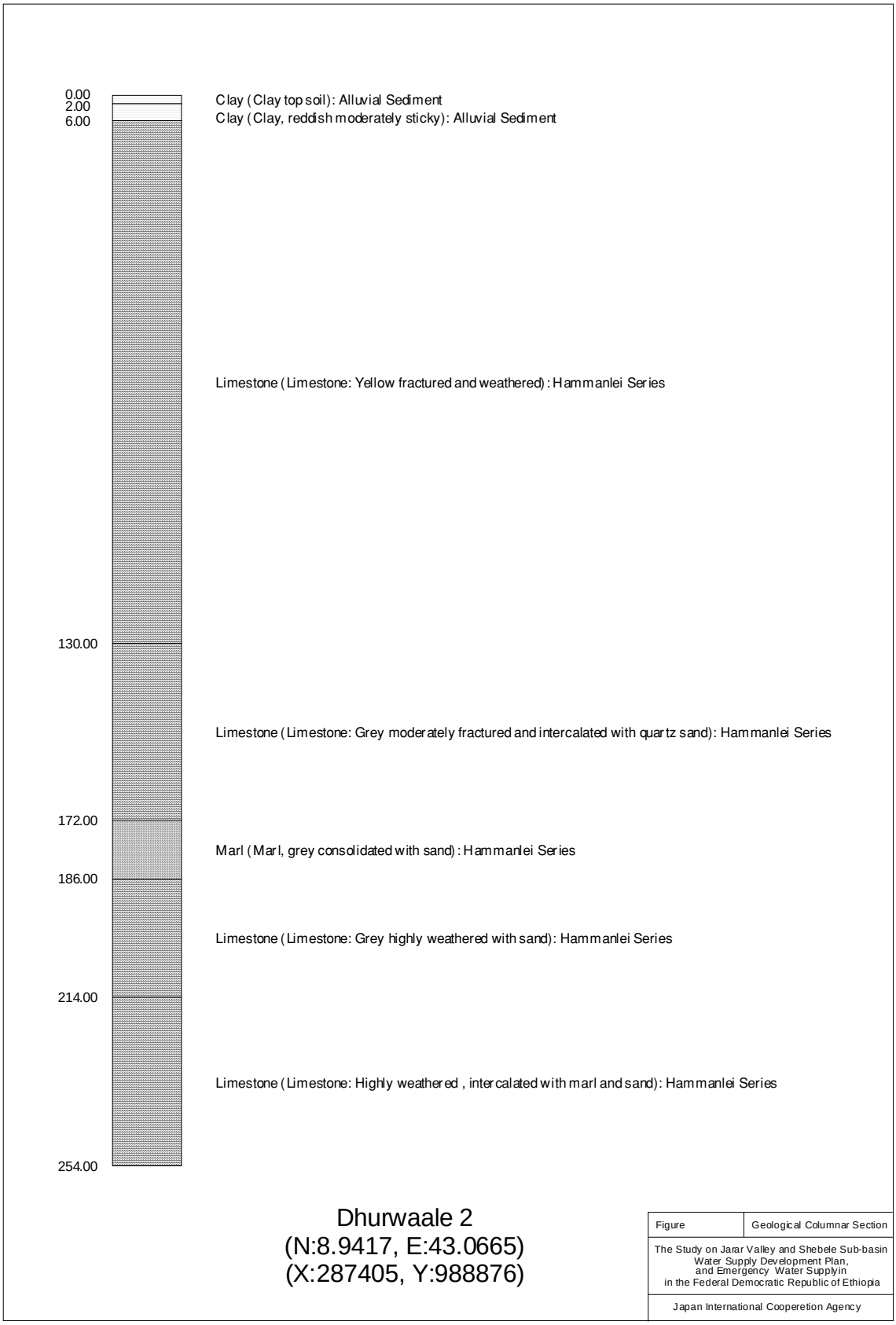
Data 1.2.4 : Geological Columnar Section for Somali Region (14/41)



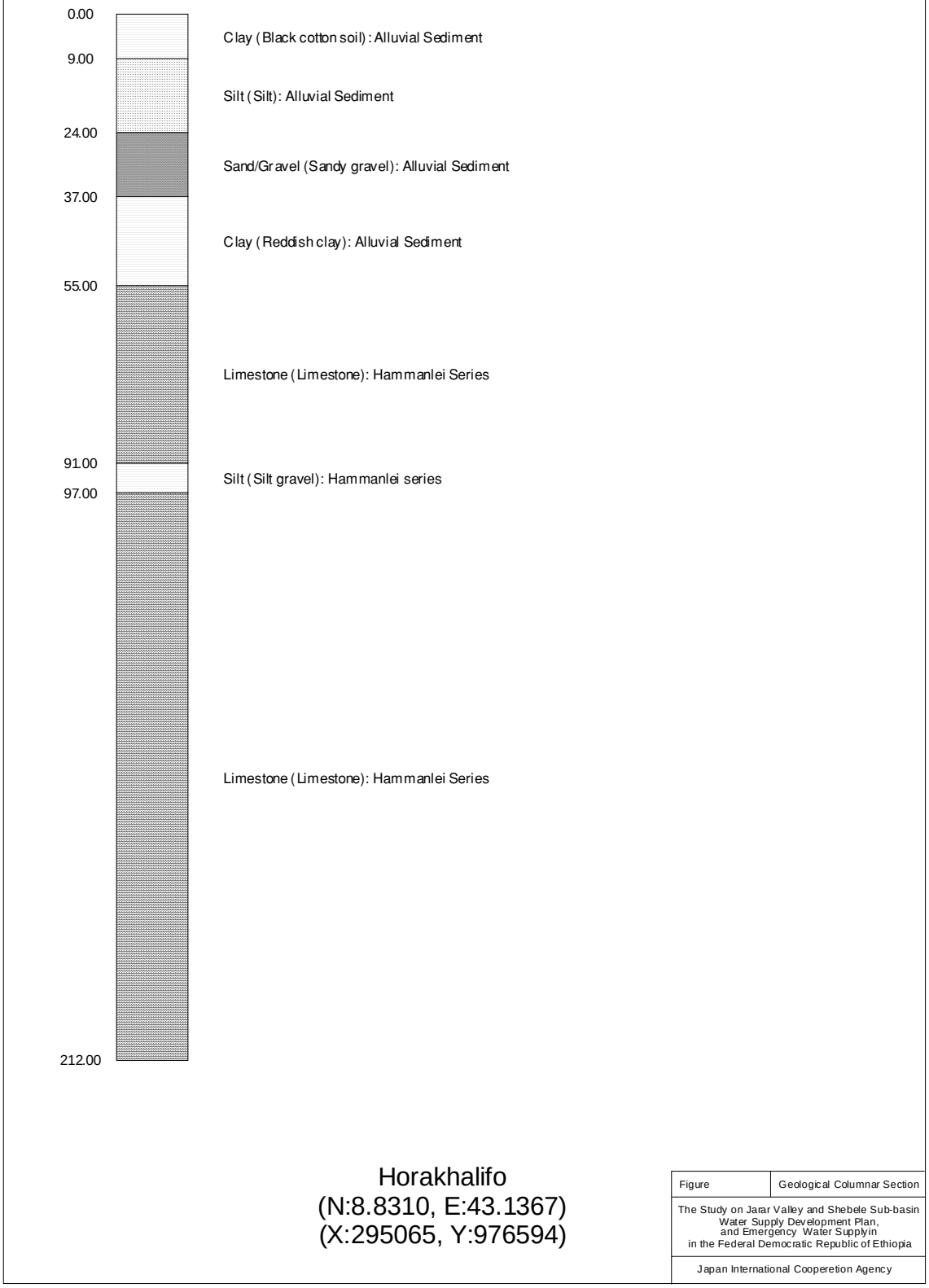
Data 1.2.4 : Geological Columnar Section for Somali Region (15/41)



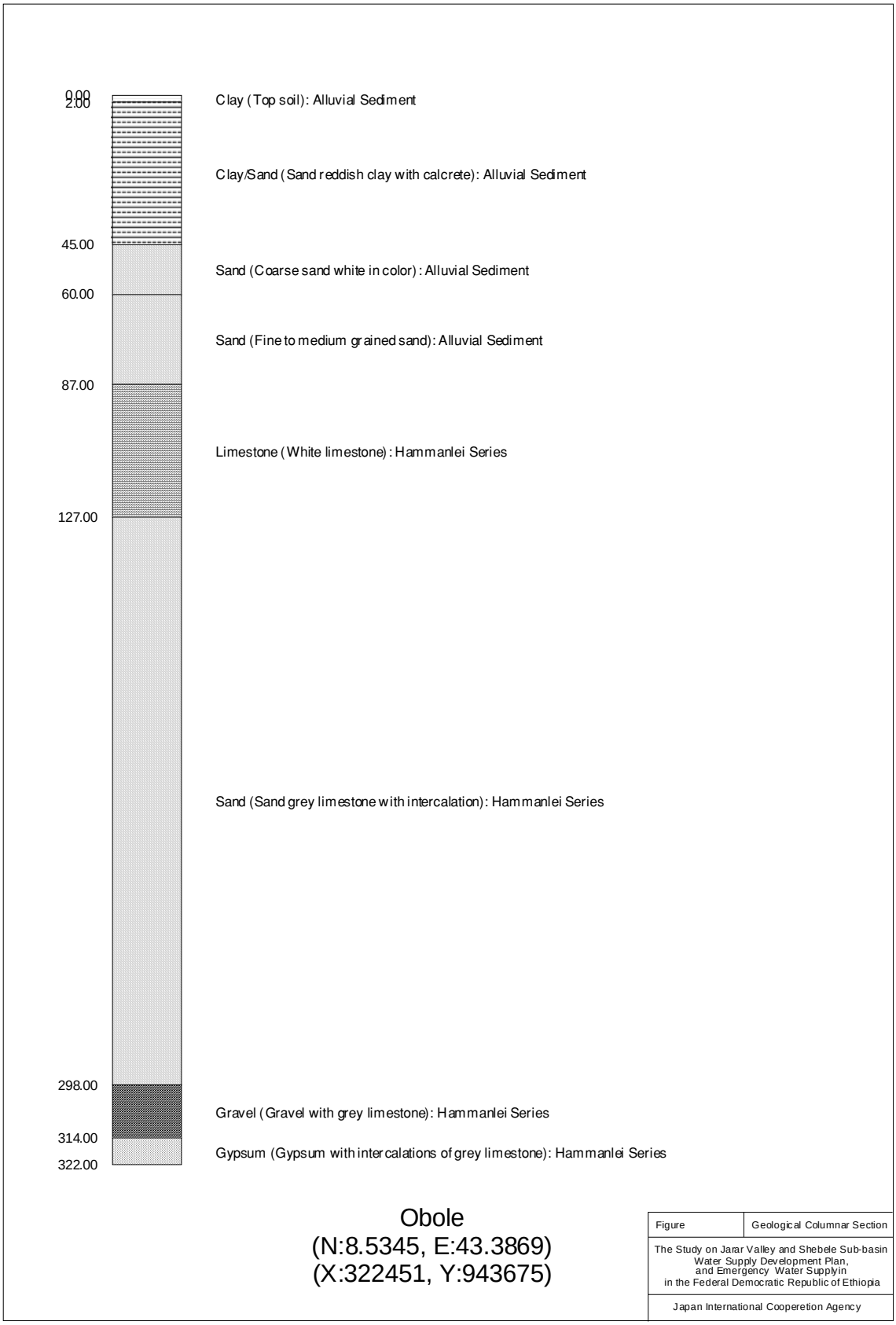
Data 1.2.4 : Geological Columnar Section for Somali Region (16/41)



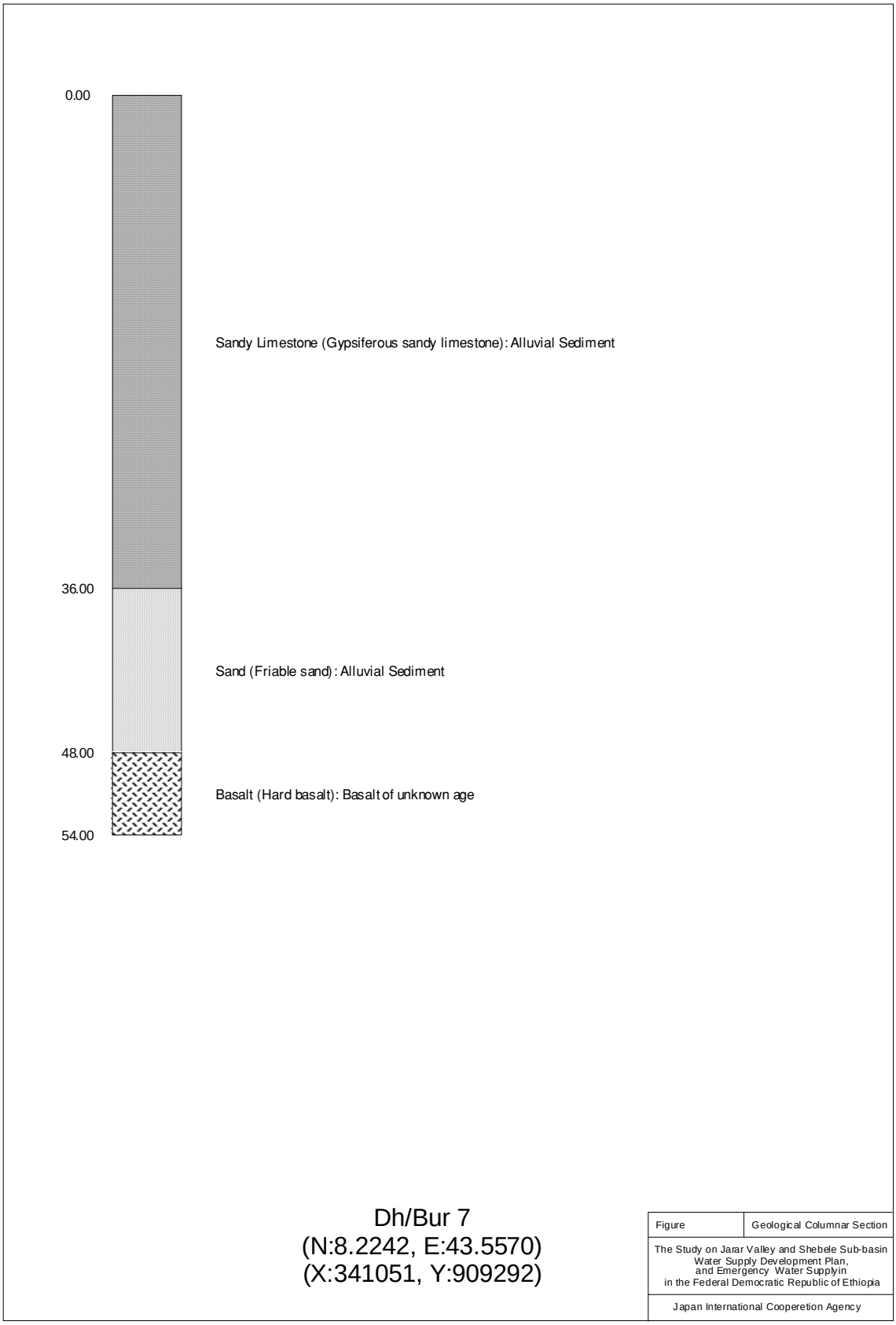
Data 1.2.4 : Geological Columnar Section for Somali Region (17/41)



Data 1.2.4 : Geological Columnar Section for Somali Region (18/41)



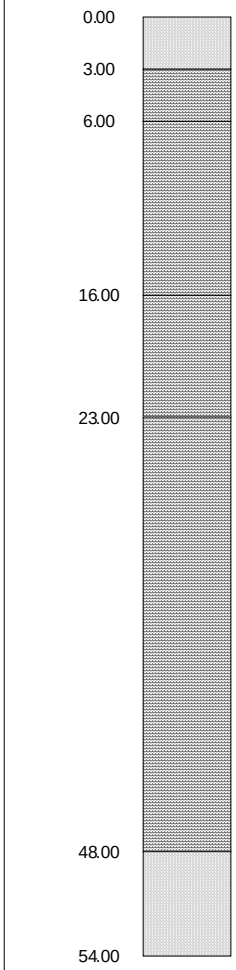
Data 1.2.4 : Geological Columnar Section for Somali Region (19/41)



Dh/Bur 7
(N:8.2242, E:43.5570)
(X:341051, Y:909292)

Figure	Geological Columnar Section
The Study on Jarar Valley and Shebele Sub-basin Water Supply Development Plan, and Emergency Water Supplyin in the Federal Democratic Republic of Ethiopia	
Japan International Cooperetion Agency	

Data 1.2.4 : Geological Columnar Section for Somali Region (20/41)



Sand (Soil- Sandy, weathered parent material to bottom): Alluvial Sediment

Limestone (Limestone - Weathered or leached): Hammanlei Series

Limestone (Limestone - Grey, hard sometimes fractured in to boulders.): Hammanlei Series

Limestone (Limestone - White, very hard massive): Hammanlei Series

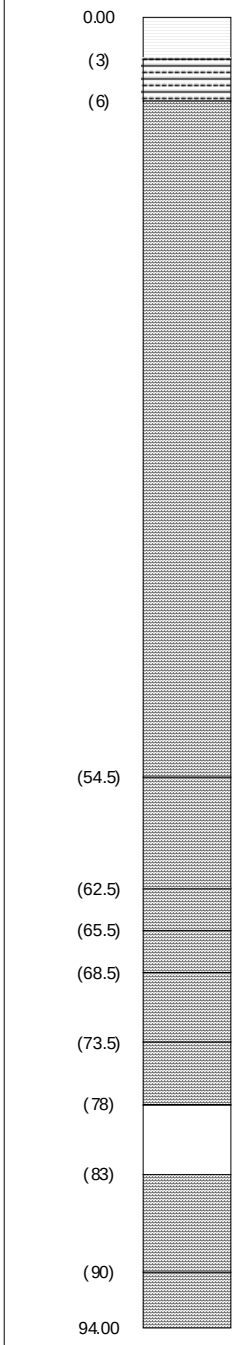
Limestone (Limestone - White, grey in color, fractured, jointed, karstified (water bearing)): Hammanlei Series

Sand (Sand - Loose uncemented, difficult to drill by C.T due to caving.): Hammanlei Series

Dh/Bur 6
(N:8.2230, E:43.5557)
(X:340908, Y:909151)

Figure	Geological Columnar Section
The Study on Jarar Valley and Shebele Sub-basin Water Supply Development Plan, and Emergency Water Supplyin in the Federal Democratic Republic of Ethiopia	
Japan International Cooperetion Agency	

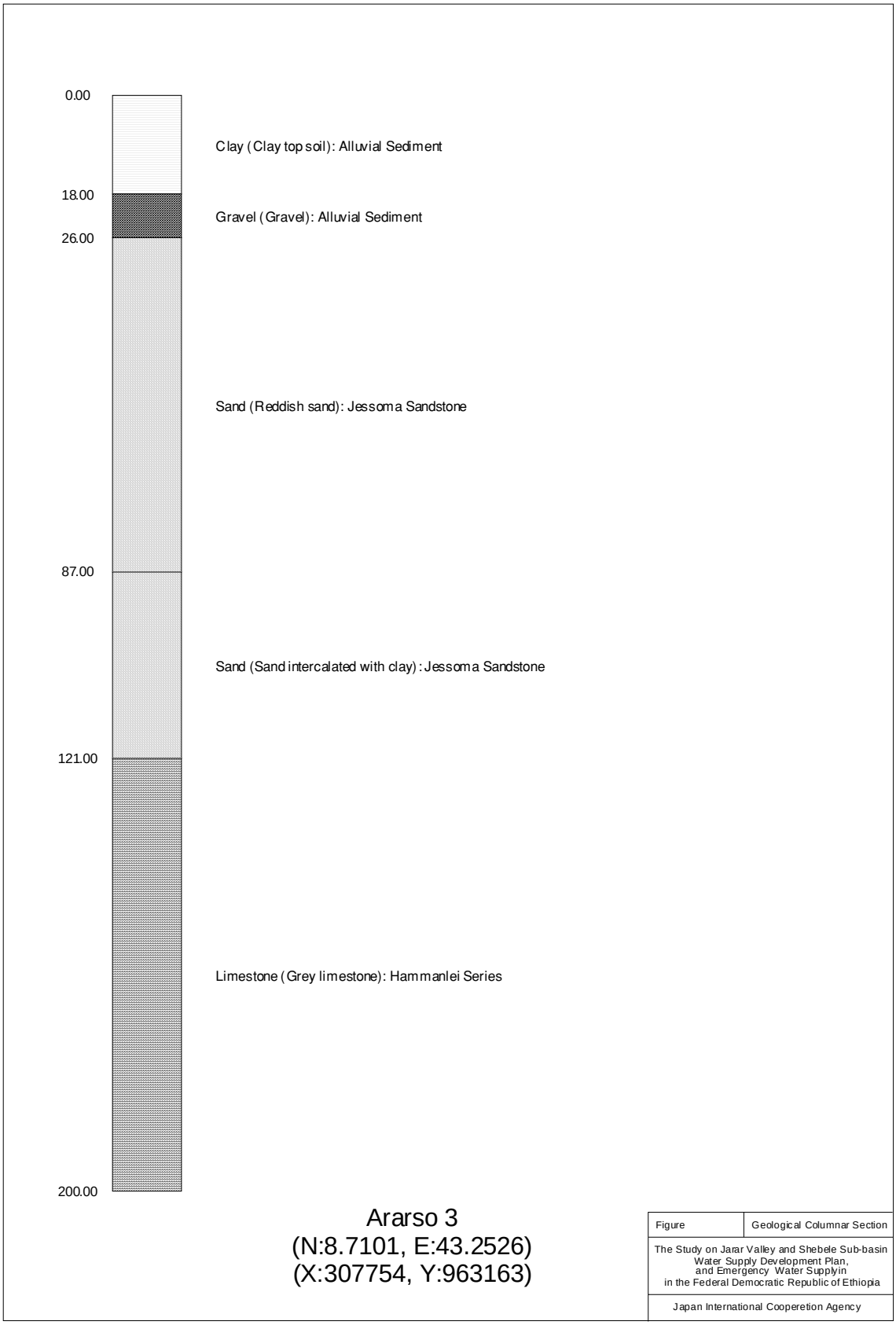
Data 1.2.4 : Geological Columnar Section for Somali Region (21/41)



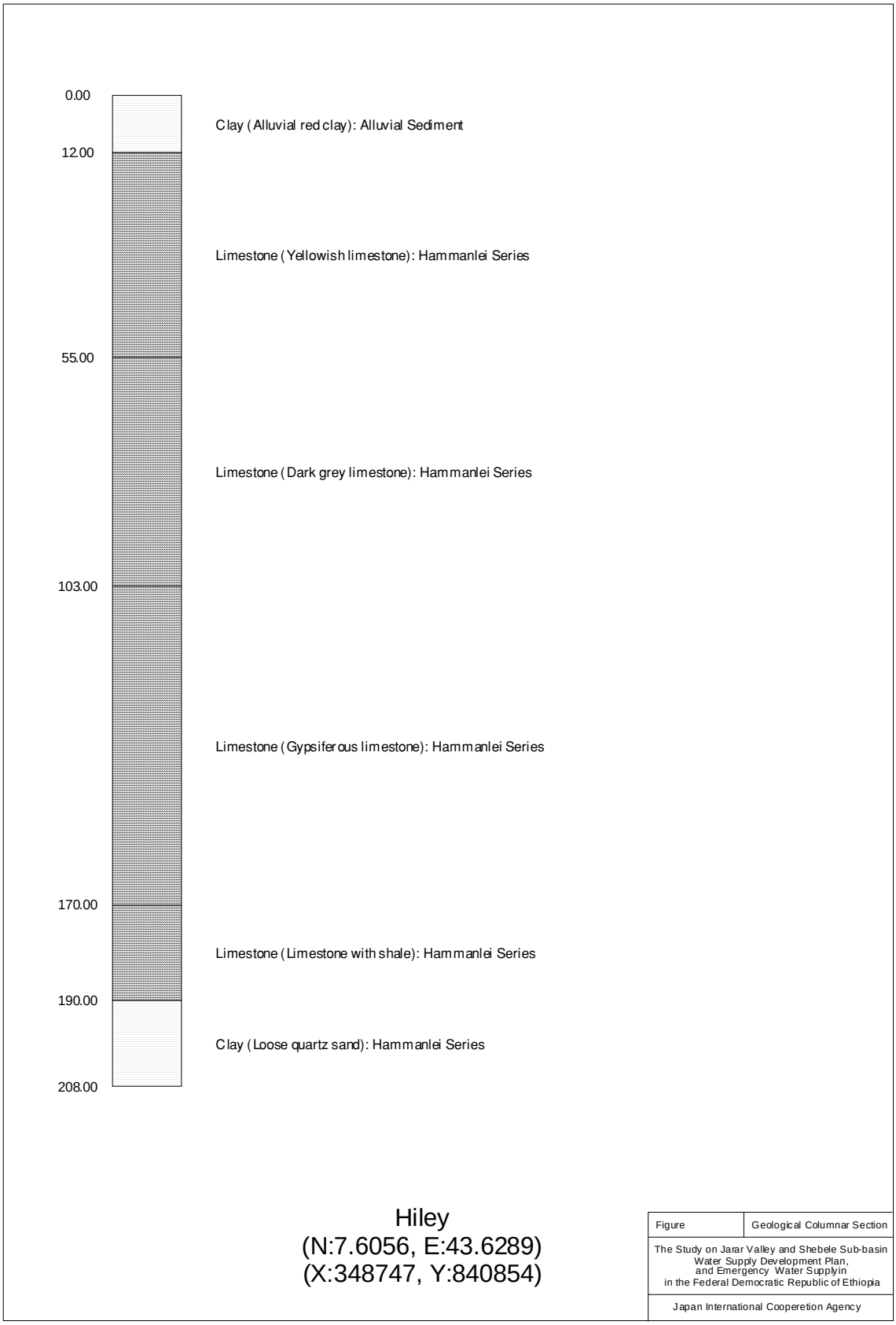
Bardahale
(N:8.0333, E:43.4667)
(X:331023, Y:888218)

Figure	Geological Columnar Section
The Study on Jarar Valley and Shebele Sub-basin Water Supply Development Plan, and Emergency Water Supplyin in the Federal Democratic Republic of Ethiopia	
Japan International Cooperetion Agency	

Data 1.2.4 : Geological Columnar Section for Somali Region (22/41)



Data 1.2.4 : Geological Columnar Section for Somali Region (23/41)



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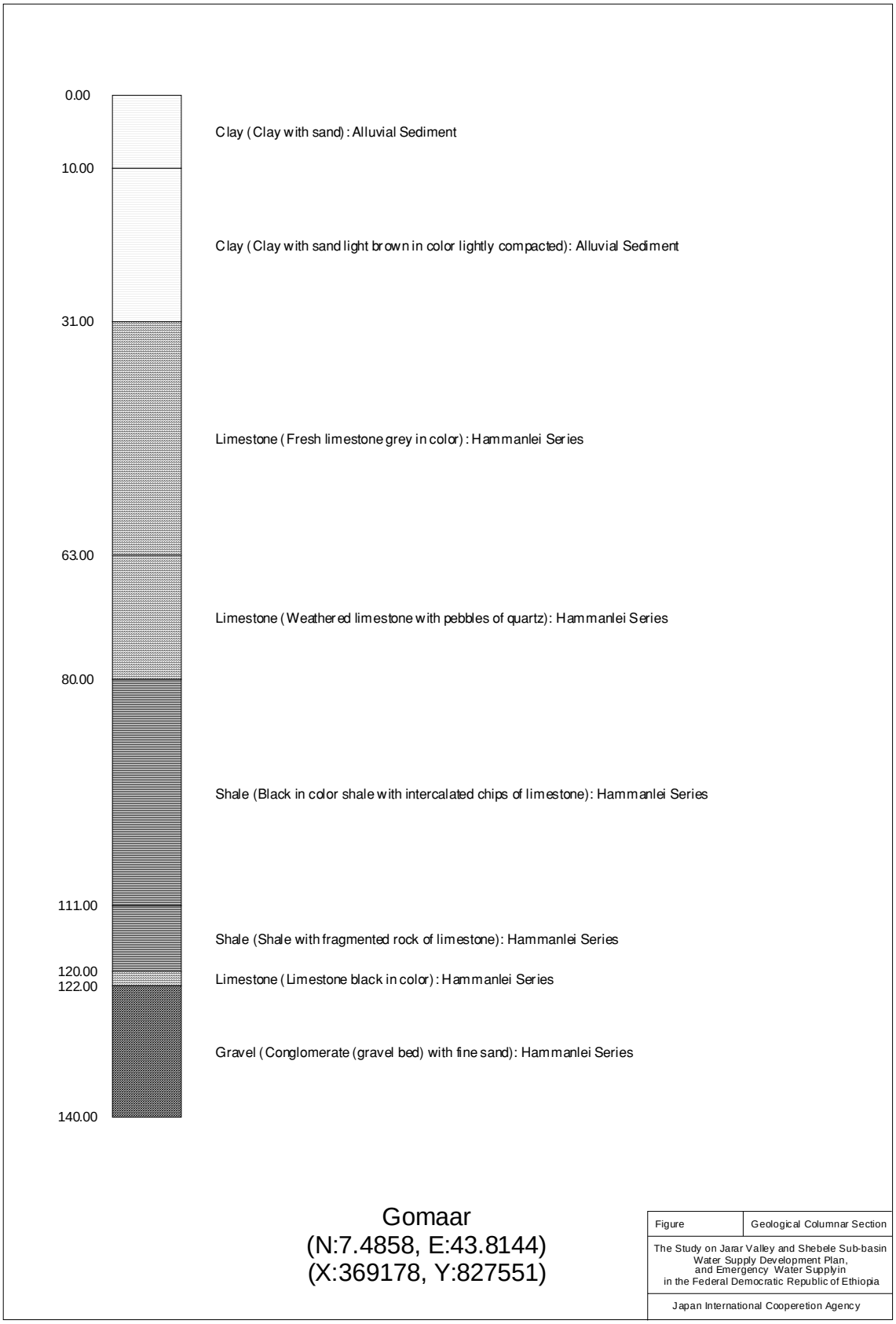
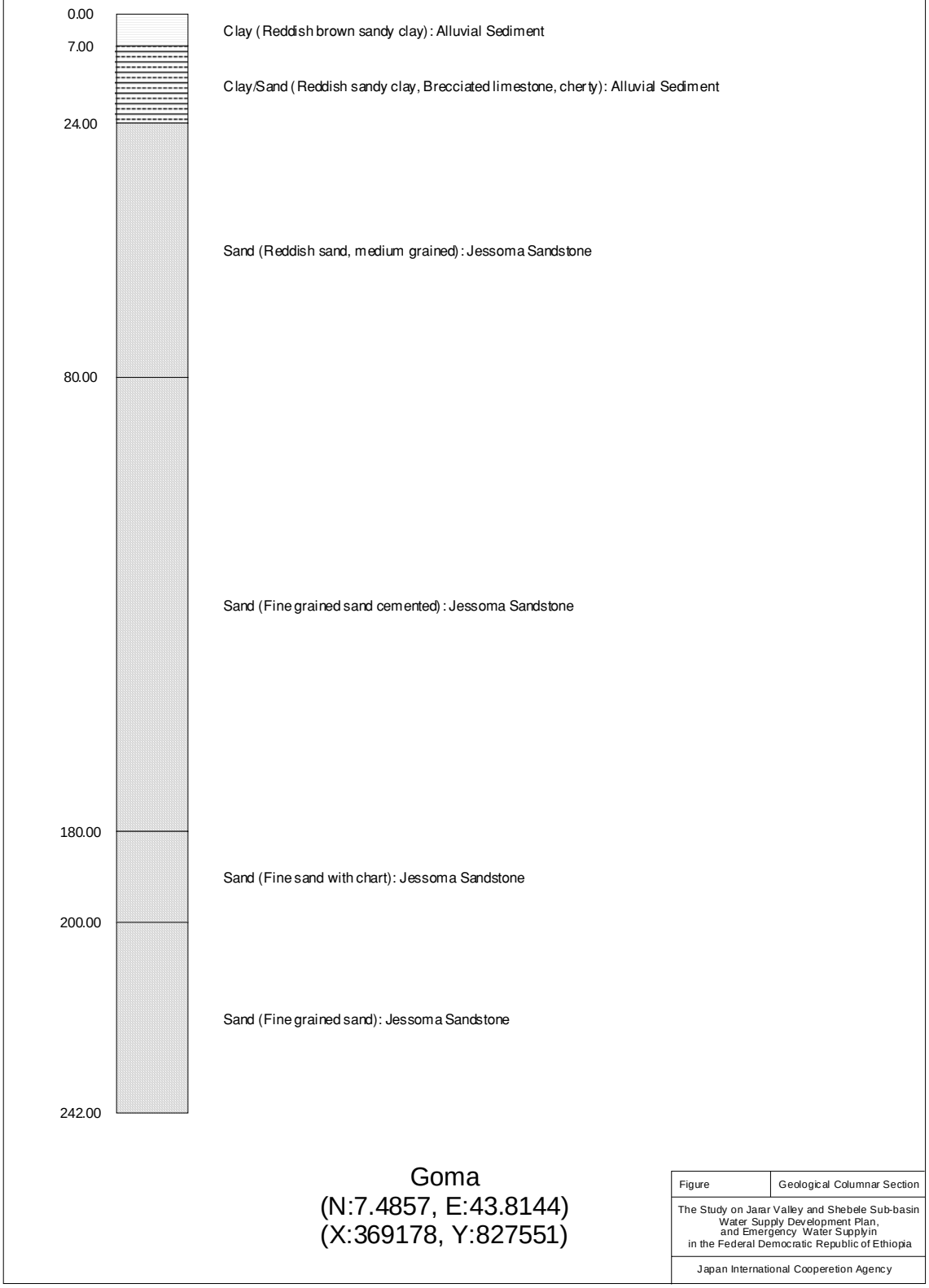
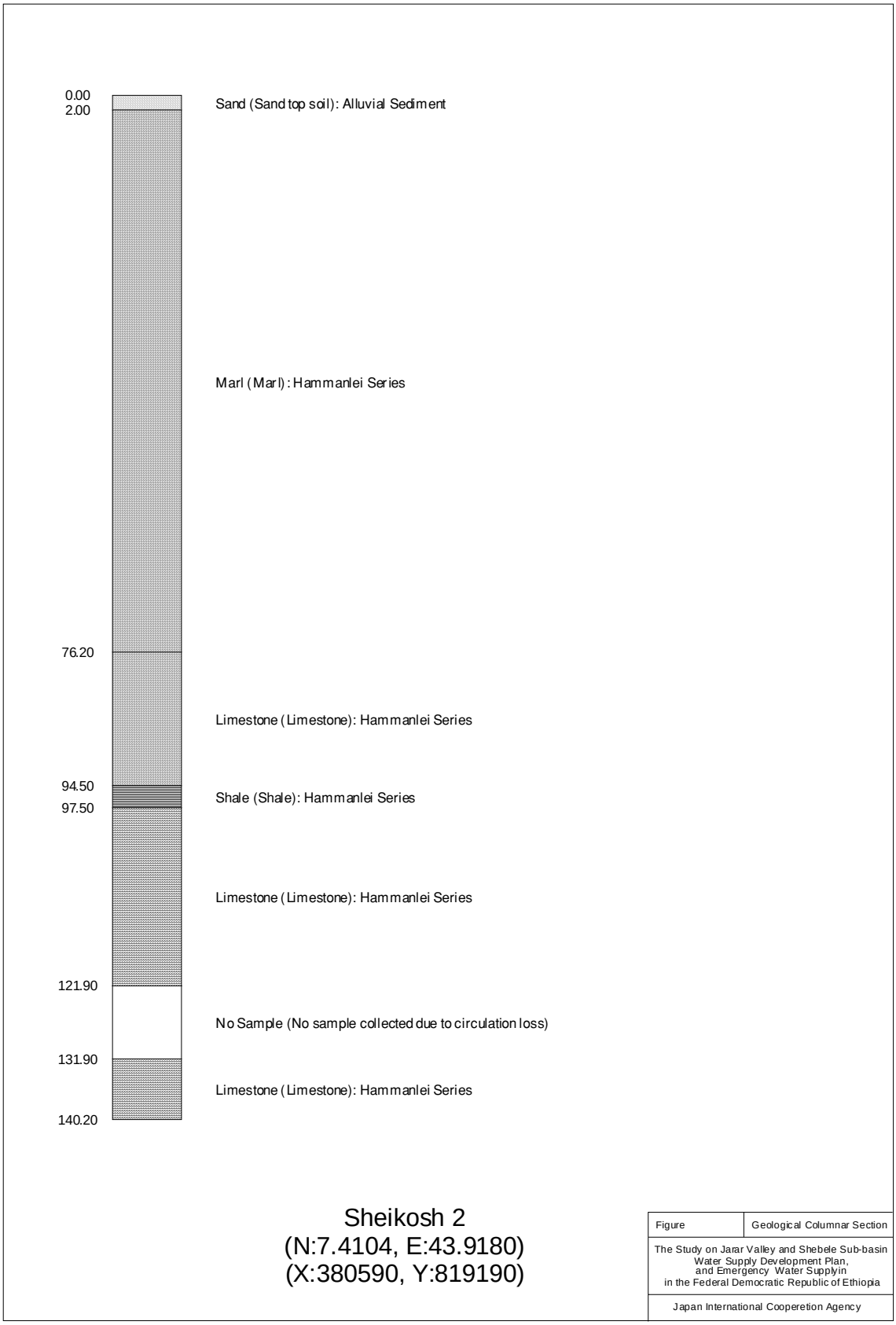


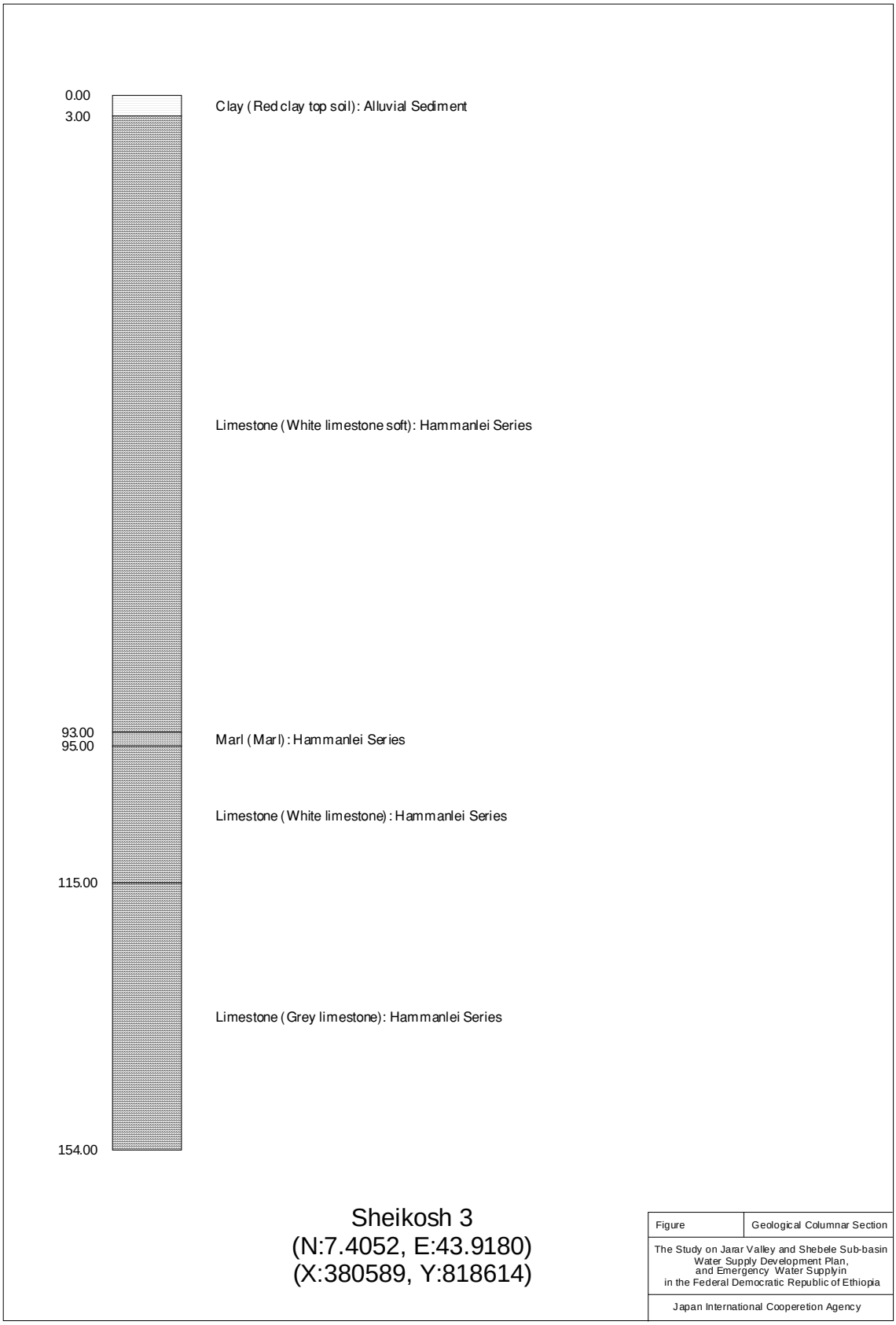
Data 1.2.4 : Geological Columnar Section for Somali Region (25/41)



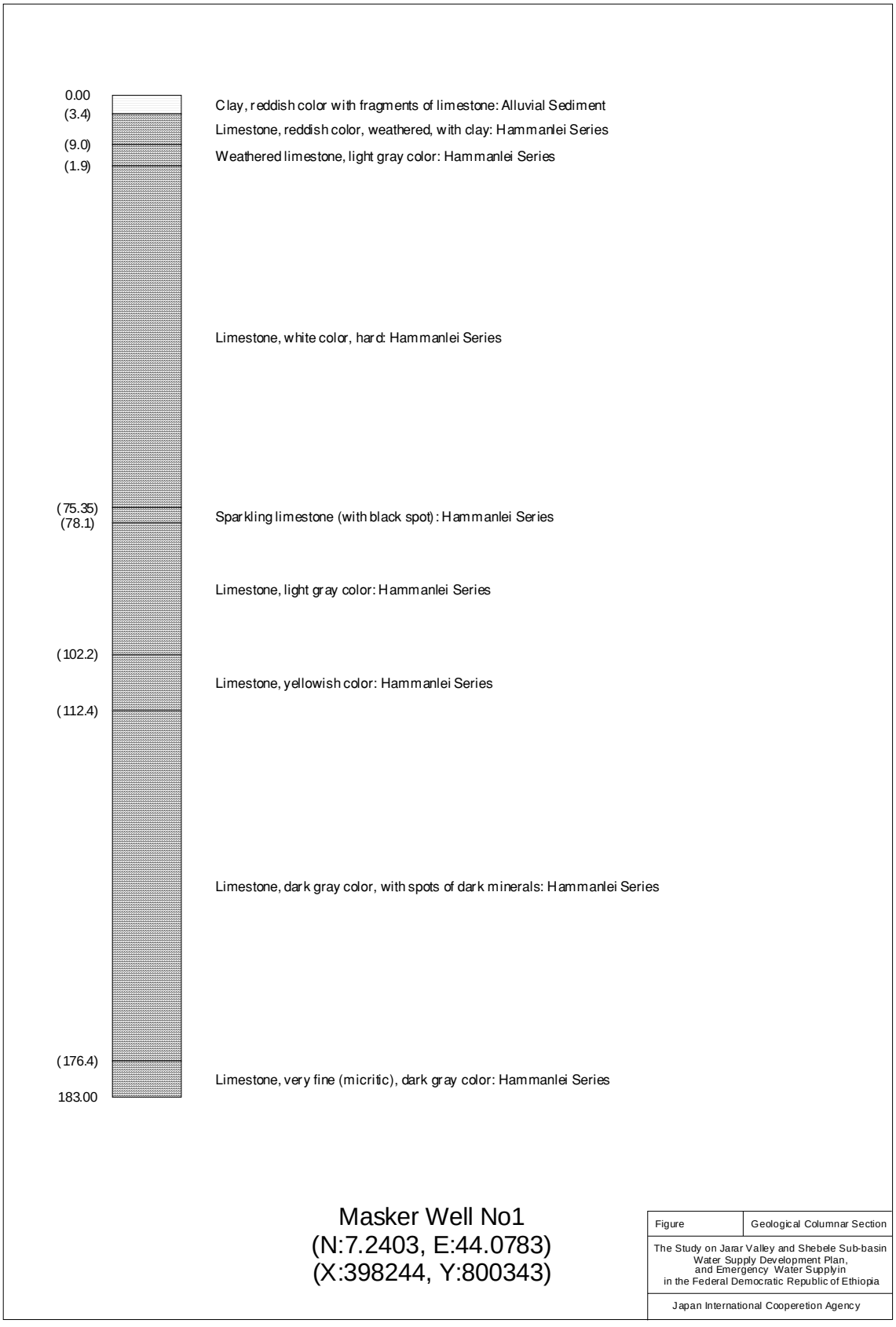
Data 1.2.4 : Geological Columnar Section for Somali Region (26/41)



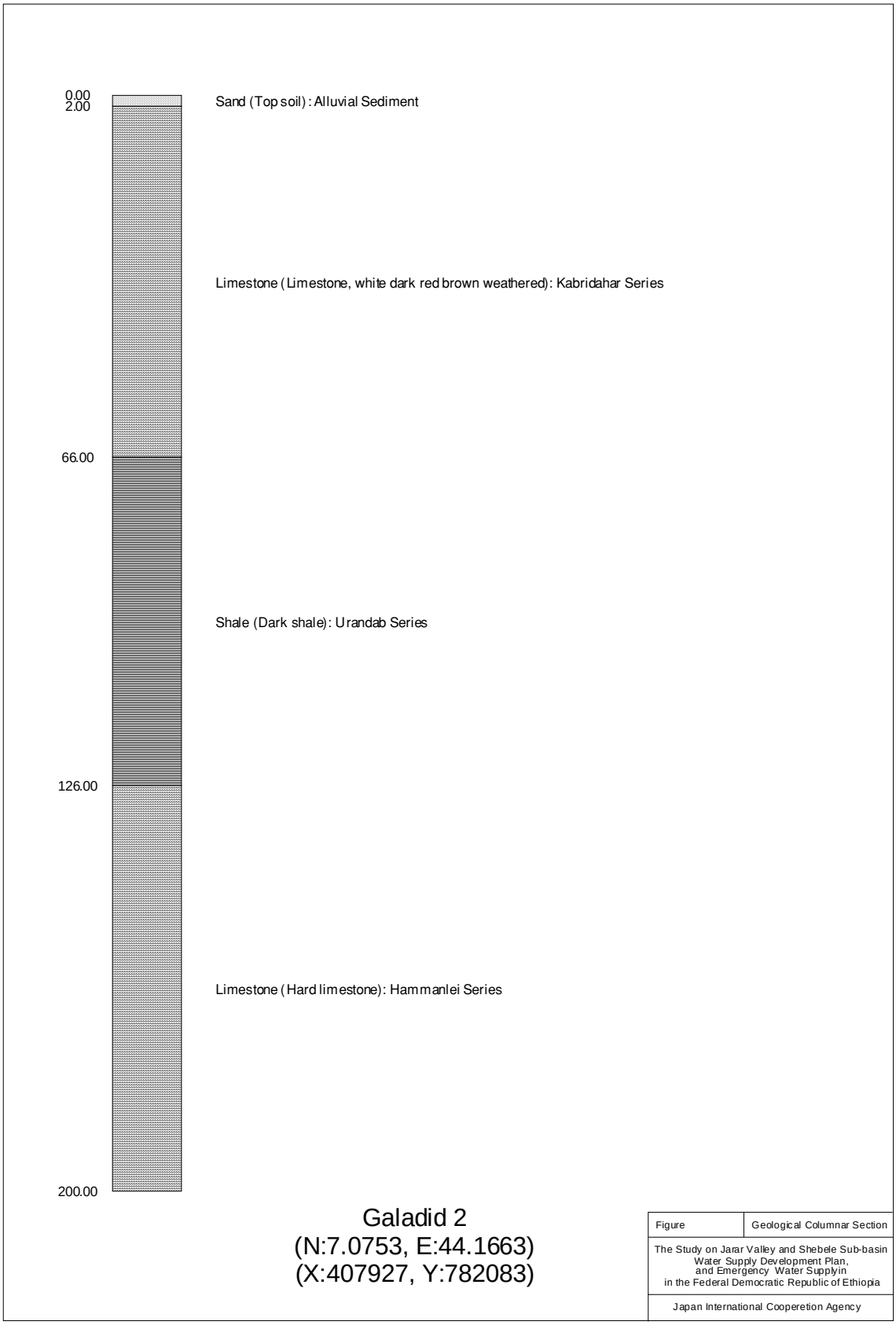
Data 1.2.4 : Geological Columnar Section for Somali Region (27/41)



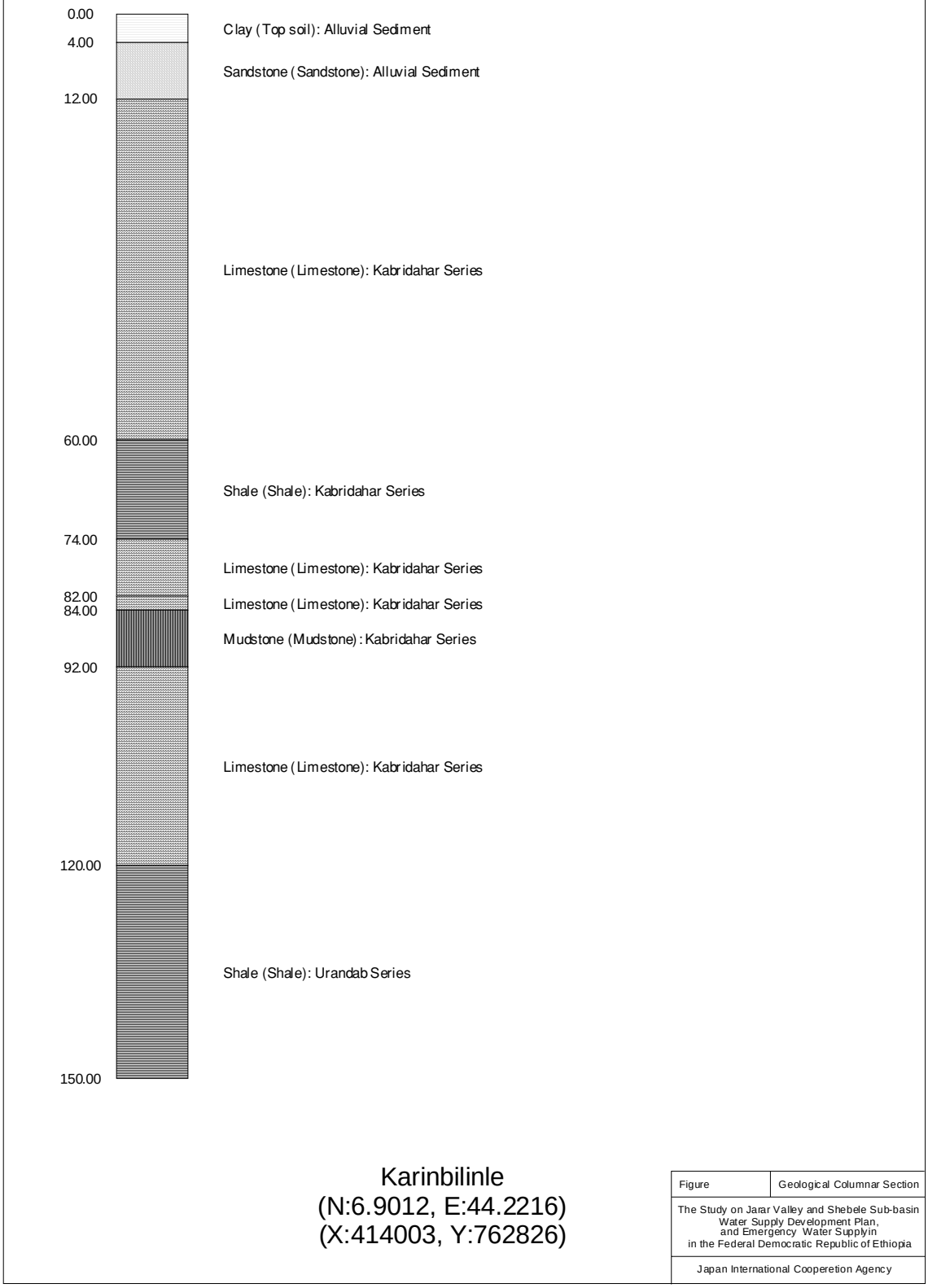
Data 1.2.4 : Geological Columnar Section for Somali Region (28/41)



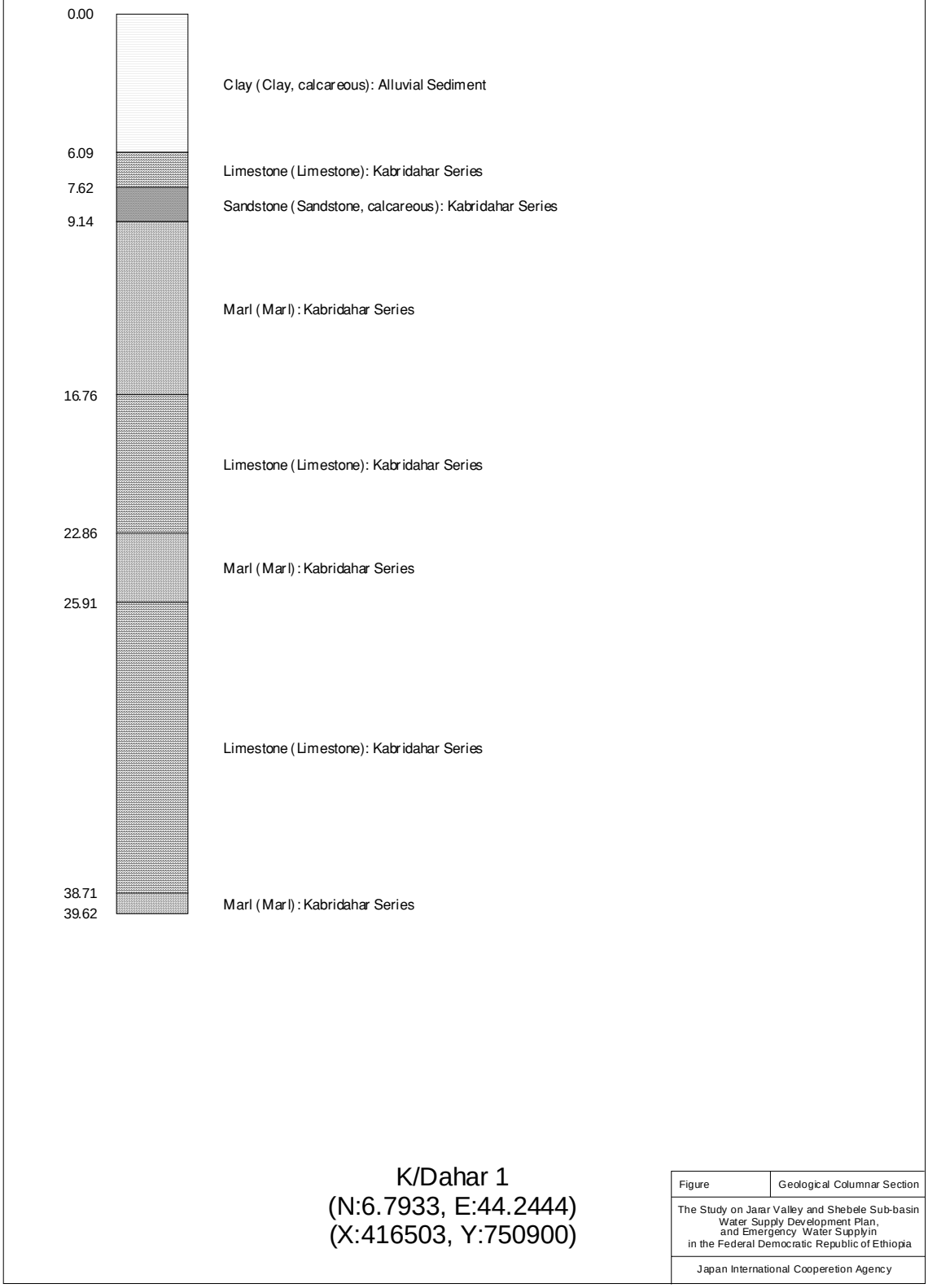
Data 1.2.4 : Geological Columnar Section for Somali Region (29/41)



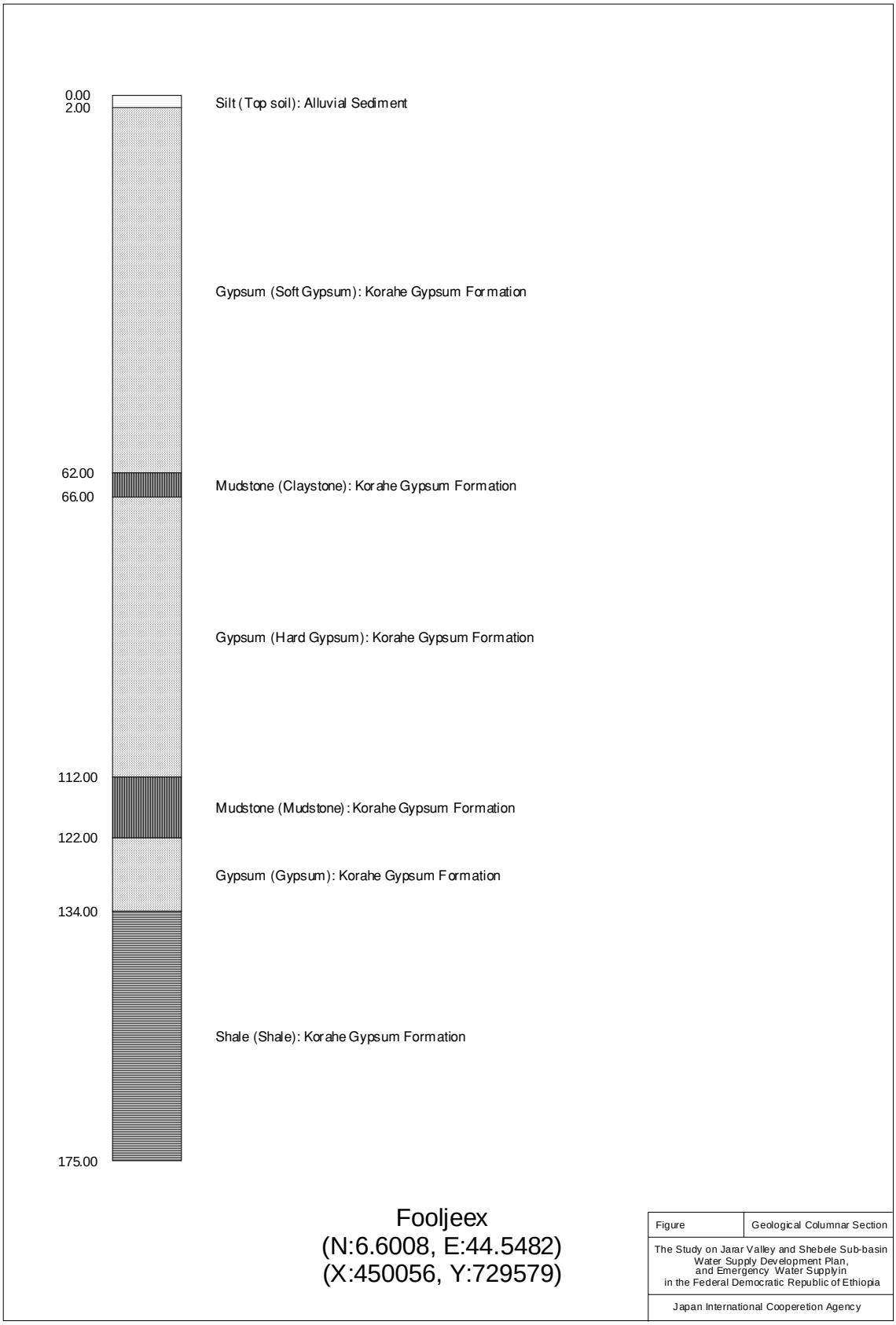
Data 1.2.4 : Geological Columnar Section for Somali Region (30/41)



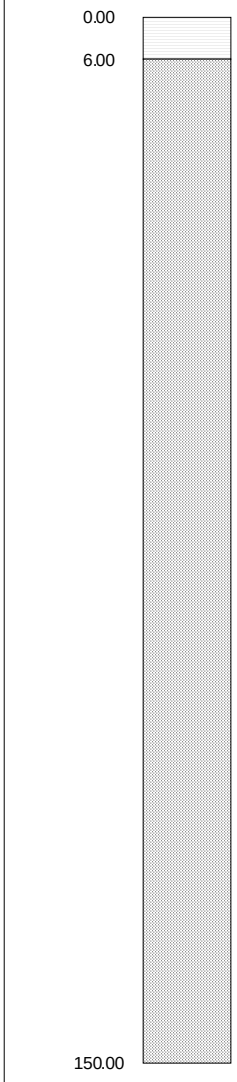
Data 1.2.4 : Geological Columnar Section for Somali Region (31/41)



Data 1.2.4 : Geological Columnar Section for Somali Region (32/41)



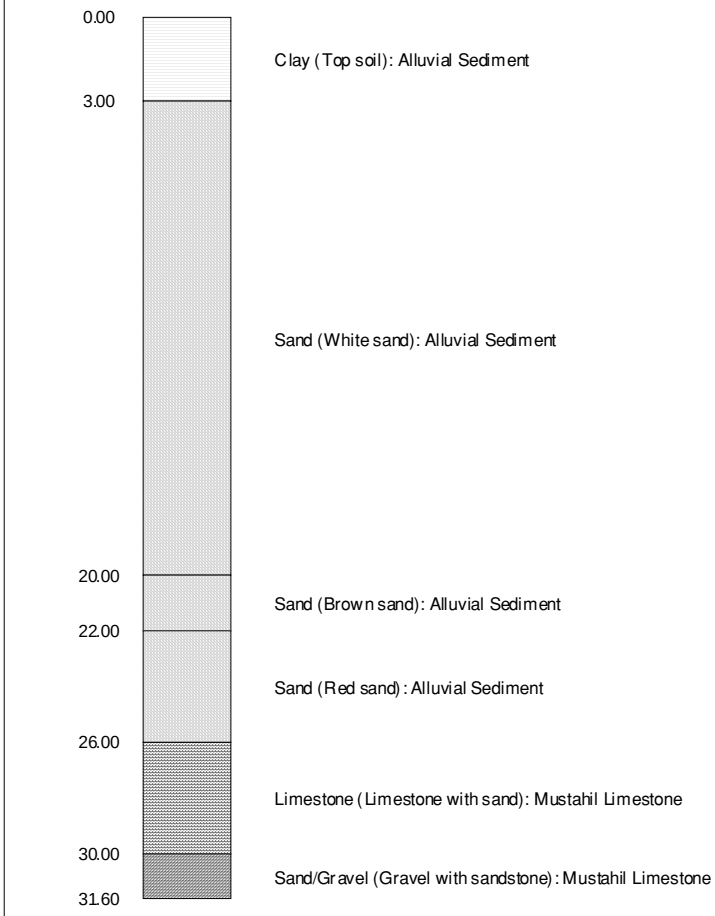
Data 1.2.4 : Geological Columnar Section for Somali Region (33/41)



X/Eyle
(N:6.5162, E:44.4394)
(X:438017, Y:720232)

Figure	Geological Columnar Section
The Study on Jarar Valley and Shebele Sub-basin Water Supply Development Plan, and Emergency Water Supplyin in the Federal Democratic Republic of Ethiopia	
Japan International Cooperetion Agency	

Data 1.2.4 : Geological Columnar Section for Somali Region (34/41)



Dhobaweyn 2
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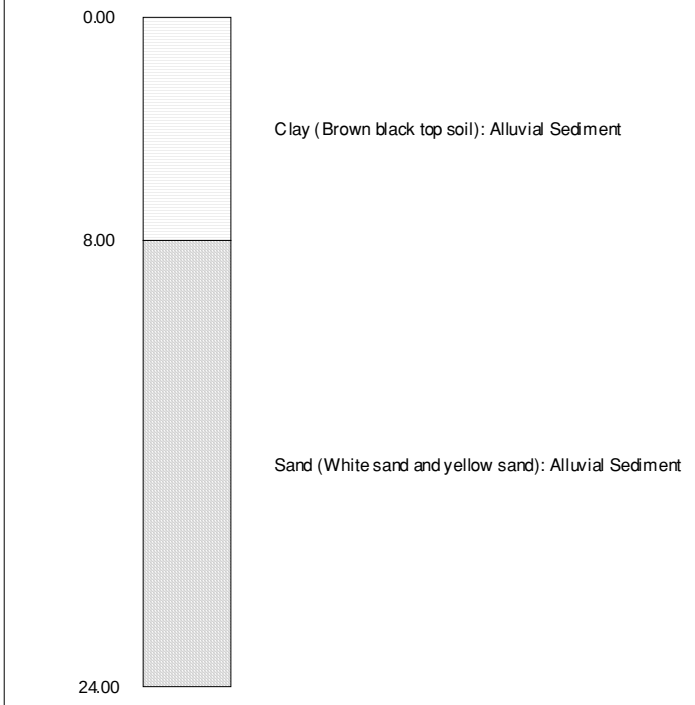
Figure	Geological Columnar Section
The Study on Jarar Valley and Shebele Sub-basin Water Supply Development Plan, and Emergency Water Supplyin in the Federal Democratic Republic of Ethiopia	
Japan International Cooperetion Agency	

Data 1.2.4 : Geological Columnar Section for Somali Region (35/41)



Dhobaweyn 3
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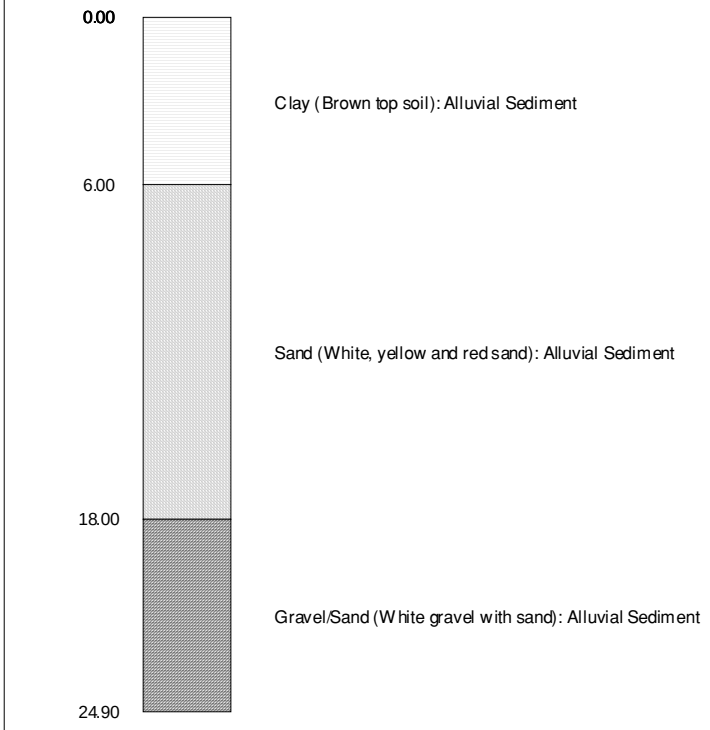
Figure	Geological Columnar Section
The Study on Jarar Valley and Shebele Sub-basin Water Supply Development Plan, and Emergency Water Supplyin in the Federal Democratic Republic of Ethiopia	
Japan International Cooperetion Agency	

Data 1.2.4 : Geological Columnar Section for Somali Region (36/41)



Dhobaweyn 4
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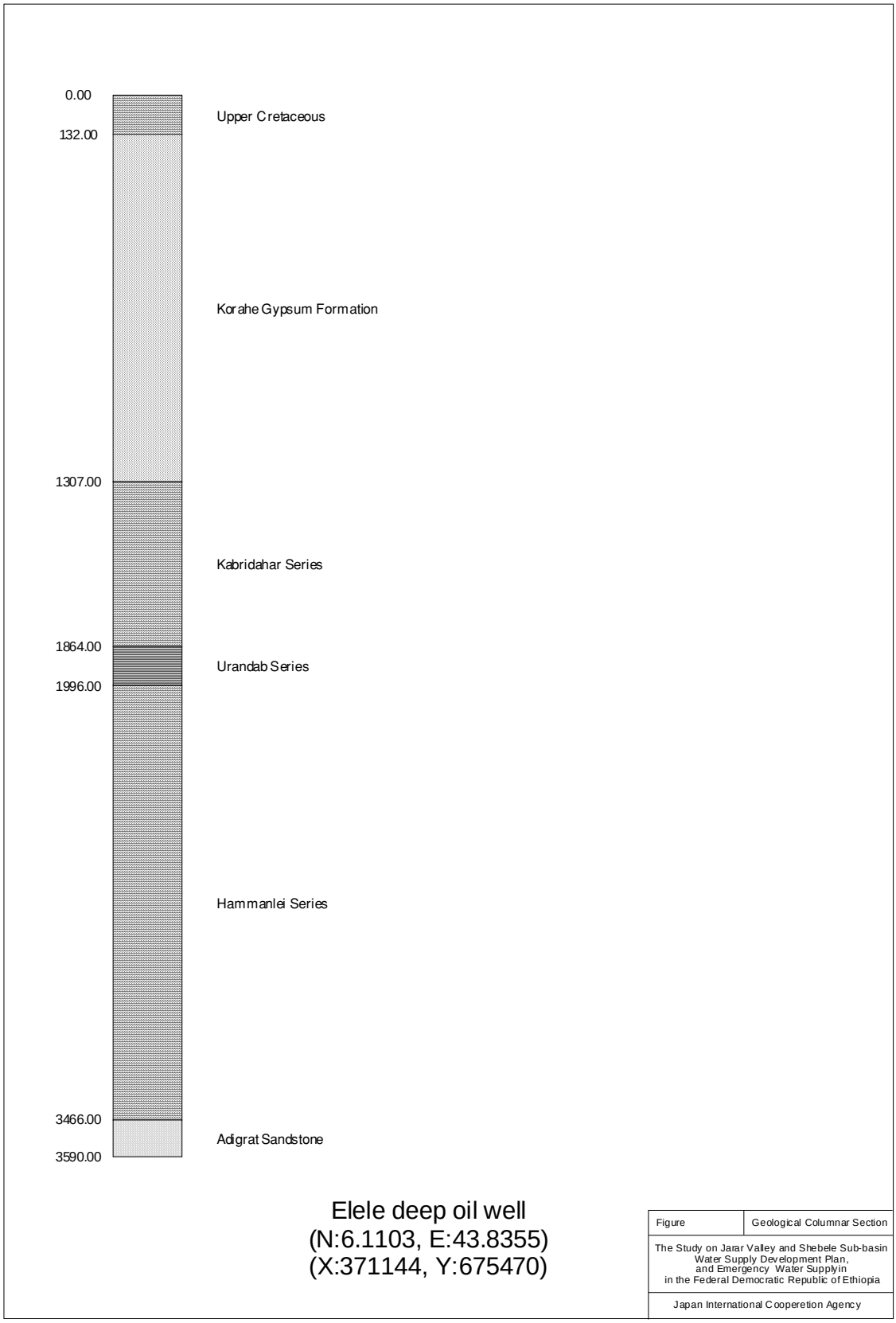
Figure	Geological Columnar Section
The Study on Jarar Valley and Shebele Sub-basin Water Supply Development Plan, and Emergency Water Supplyin in the Federal Democratic Republic of Ethiopia	
Japan International Cooperetion Agency	

Data 1.2.4 : Geological Columnar Section for Somali Region (37/41)



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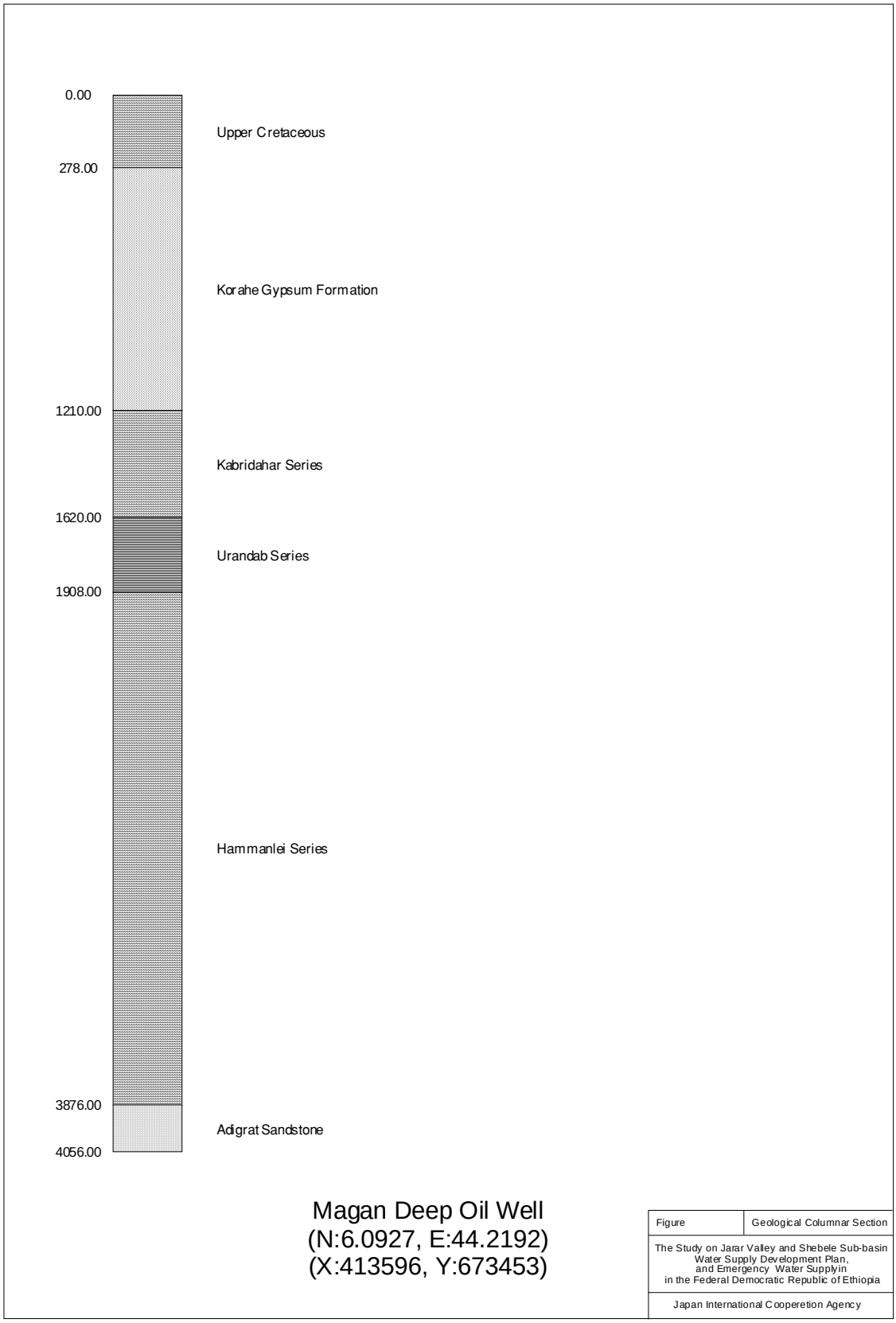
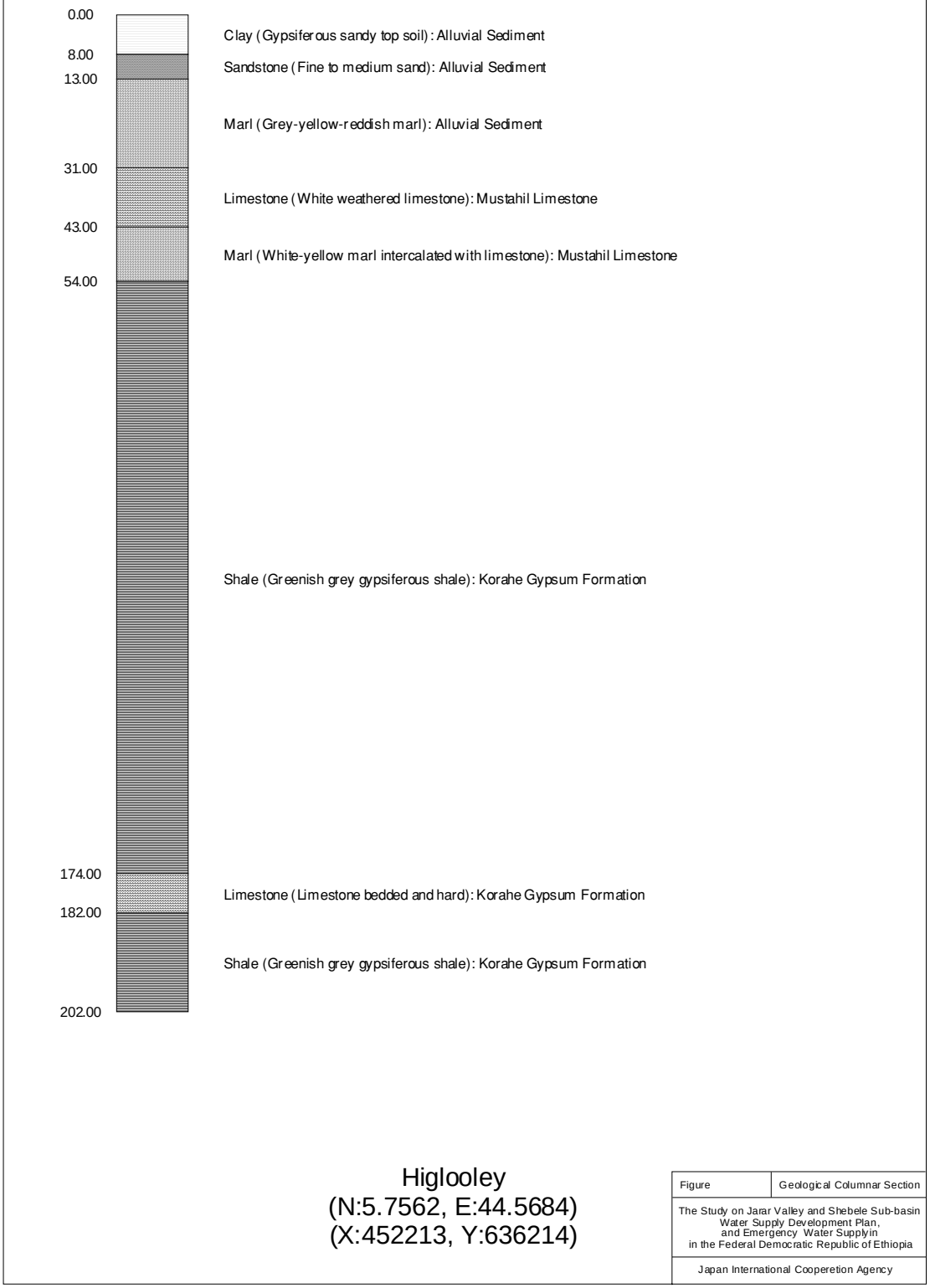


Data 1.2.4 : Geological Columnar Section for Somali Region (39/41)



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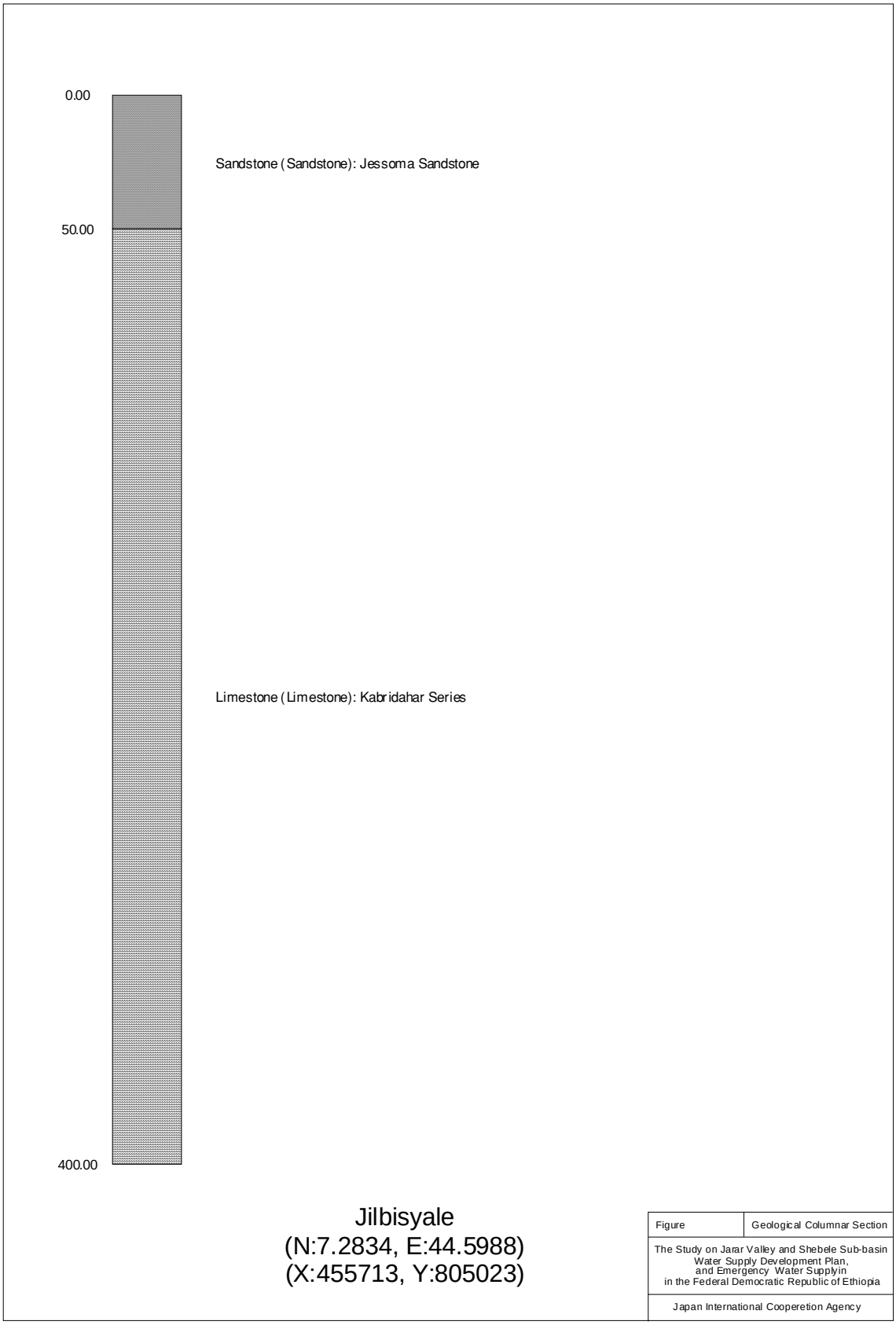

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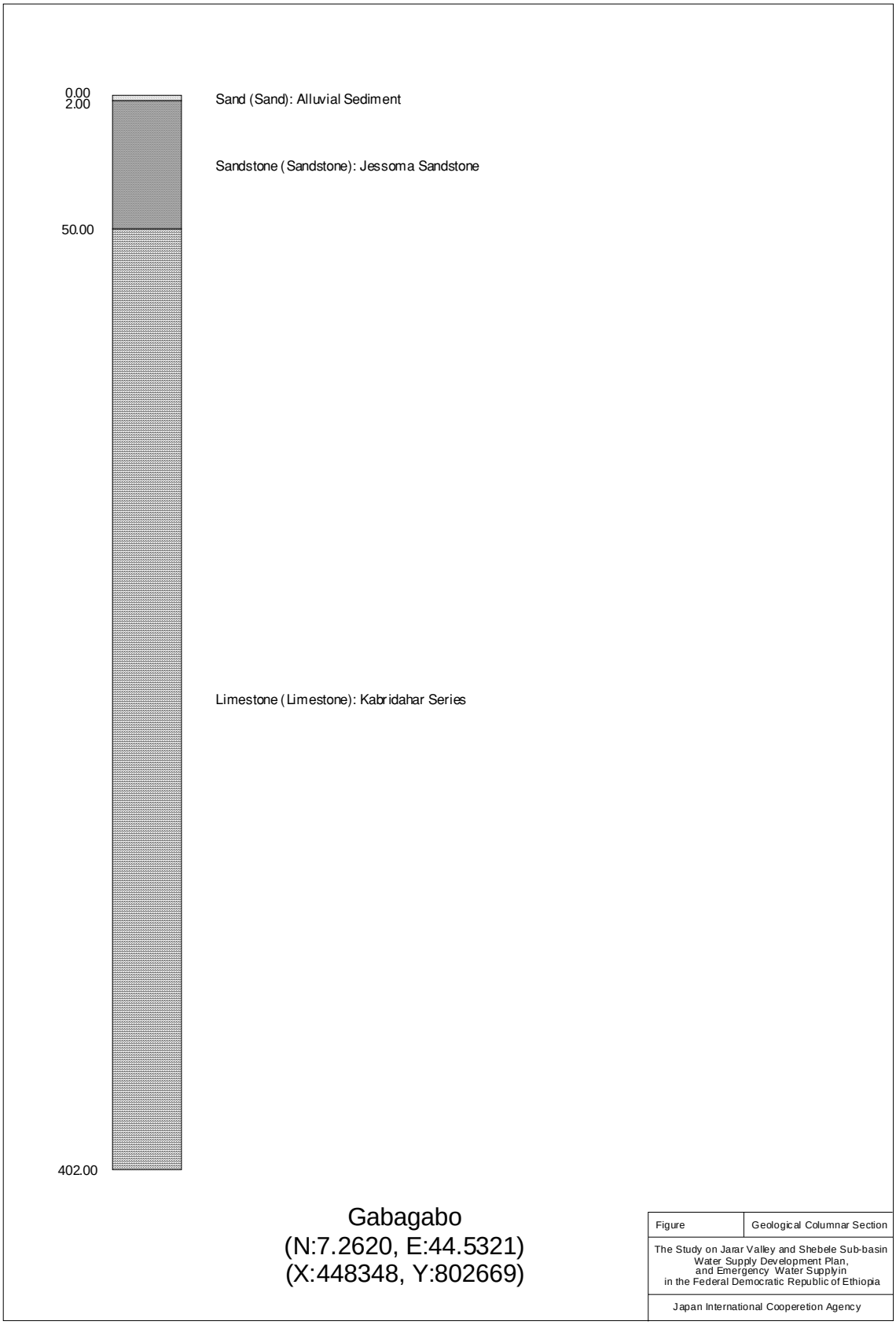

Volume.1

3. Water Quality Survey

3. Water Quality Survey

Data 1.3.1 : Result of Water Quality Analysis (1/2)

S/No	Code	Site	Source Type	Kebale	Woreda	Date	Geology	W type	Longitude	Latitude	CO_3 (meq/l)	HCO_3 (meq/l)	T.P(ppm)	NH_4 (ppm)	SO_4 (ppm)	NO_3 (ppm)	Turbidity(FTU)	F (mg/l)	TSS (mg/l)	TDS(ppm)	pH	EC(mS/cm)	Cl (ppm)	Ca(ppm)	Mg(ppm)	Na(ppm)	K(ppm)	Mn(ppm)	Fe(ppm)	Hardness (mg/l $CaCO_3$)
WHO		Guideline Value														50		1.5										0.4		
		Acceptable Value												1.5	250		5			1000			250			200		0.1	0.3	
Ethiopia														2	483	50		3.0		1776	6.5-8.5		533			358		0.13	0.4	392
1	JV001	Qaaxo	BH	Kabribayah Town	Kabribayah	2012/5/28	Hamanlei	Ca-Mg	43.013151	8.990637	4	3	0.048	0.035	175.7	0.128	36.95	1.204	590	1852.11	7.22	1.434	195	849.6	156.35	64.53	11.93	0.047	0.113	1550
2	JV002	UNHCR-BH2	BH	Kabribayah Town	Kabribayah	2012/5/29	Hamanlei	Ca-Mg-Cl	43.006749	9.033903	6	2	0.355	0.446	171.3	0.128	4.6	0.903	870	1731.98	7.34	0.969	445	480	145.24	96.04	17.5	0.009	0.057	890
3	JV003	EB2	BH	Kabribayah Town	Kabribayah	2012/5/29	Hamanlei	Mg-Ca-Cl-CO_3	43.016811	9.008257	12	2	0.382	0.108	147.5	0.148	143	0.903	1304	1631.86	7.22	0.814	490	275.2	173.49	112.55	18.29	0.019	0.075	740
4	JV004	Treatment	Treatment	Kabribayah Town	Kabribayah	2012/6/29		Ca-Mg-Cl-CO_3	43.018855	9.010175	6	1	<0.002	0.077	146.3	0.113	4.26	0.937	696	1432	7.57	0.774	425	296	142.38	105.05	15.11	0.019	0.151	700
5	JV005	KB Reserviour	Treatment	Kabribayah Town	Kabribayah	2012/5/29		Ca-Mg-Na-Cl	43.166778	9.108825	2	4	0.088	0.056	141.2	0.152	0	0.87	840	1531.75	7.82	1.28	400	331.2	127.62	123.05	21.47	0.028	0.057	900
6	JV006	KB Tap water	Treatment	Kabribayah Town	Kabribayah	2012/5/30		Ca-Mg-Cl-HCO_3	43.179469	9.097877	2	5	0.191	0.045	144.2	0.121	0	1.02	690	1386	7.79	0.871	345	316.8	109.37	109.55	1.59	0.019	0.019	800
7	JV007	Dameerboob	BH	Alleybadey	Kabribayah	2012/5/30	Jessoma	Ca-Mg-Na-Cl	43.478561	9.40294	4	2	0.84	0.143	168.2	0.109	1.38	0.786	624	1882.15	8.23	1.071	505	248	128.1	172.58	17.5	0.019	0.075	880
8	JV008a	Alelaleh	BH	Alelaleh	Kabribayah	2012/4/6	Hamanlei	Mg-Ca-CO_3-HCO_3-SO_4	43.12268	8.9166	3	4	0.091	0.0125	135.6	0.125	243.6	0.921	3830	1224	7.65	1.105	45	125.8	85.6	7.56	0.009	0.034	0.85	850
9	JV009	Sangumare	BH	Sangumare	Ararso	2012/4/6	Hamanlei	Ca-Mg-Cl	43.33764	8.671703	2	4	0.015	0.495	171.5	0.113	97	1.321	1216	2713.09	7.28	1.359	440	817.6	168.25	94.54	24.65	0.575	0.358	2010
10	JV010	Holjiid	BH	Holjiid	Ararso	2012/4/6	Hamanlei	Ca-Mg-Cl	43.290665	8.609164	6	2	0.004	0.185	175.5	0.109	0.87	0.819	566	2002.28	7.38	1.177	500	544	171.75	127.56	7.95	0.028	0.075	1000
11	JV011	Dikrelay BH	BH	Dikrelay BH	Ararso	2012/4/6	Hamanlei	Ca-Mg-Cl	43.395544	8.666236	2	2	0.295	1.997	172.2	0.148	87	1.438	1488	3143	7.51	1.897	395	1240	169.52	100.54	36.58	0.123	0.34	2500
12	JV012	Towlane	BH	Dhagahbur Town	Dhagahbur	2012/5/6	Basalt	Ca-Na-Mg-HCO_3-CO_3	43.526822	8.230041	6	7	0.04	0.54	130.7	0.132	10.92	1.304	780	1167	7.8	1.021	55	145.6	83.02	157.57	6.36	0.009	0.038	530
13	JV012a	Towlabe BH8	BH	Dhagahbur Town	Dhagahbur	2012/7/7	Basalt	Mg-Ca-Na-CO_3	43.5113	8.24666	5	4	0.215	0.231	185.6	0.201	15.6	1.125	895	895	7.41	1.235	126	235	151.5	235	19.23	0.015	0.065	632
14	JV013	Horwarableh	BH	Dhagahbur Town	Dhagahbur	2012/5/6	Basalt	Ca-Mg-Na-Cl	43.573417	8.203686	6	3	0.036	0.171	164	0.109	15.3	1.171	698	3644.26	7.38	1.819	935	649.6	159.84	232.6	18.29	0.019	0.189	1920
15	JV014	Horwarableh	BH	Dhagahbur Town	Dhagahbur	2012/5/6	Basalt	Ca-Mg-Cl	43.572406	8.201992	4	5	<0.002	0.105	183.7	0.125	12.49	1.171	828	3744.27	7.04	2.995	1030	836.8	158.73	231.1	18.29	0.047	0.132	1860
16	JV015	Horwarableh	BH	Dhagahbur Town	Dhagahbur	2012/5/6	Basalt	Ca-Mg-Na-Cl	43.573347	8.200223	4	5	0.006	0.063	161.8	0.105	58	1.221	768	2633	7.61	1.512	610	571.2	160.16	202.59	13.52	0.142	1.585	1310
17	JV016	Horwarableh	BH	Dhagahbur Town	Dhagahbur	1900/1/9	Basalt	Ca-Mg-Na-Cl	43.574372	8.205444	6	4	0.263	0.087	158.2	0.125	47.45	1.02	918	4505.14	7.42	2.438	1055	792	174.13	276.12	22.27	0.028	0.094	2140
18	JV017	Horwarableh HDW	HDW	Dhagahbur Town	Dhagahbur	2012/5/6	Alluvial	Ca-Mg-CO_3-SO_4	43.57763	8.192841	4	1	0.104	0.268	160.5	0.163	1.13	1.037	176	690	7.62	1.1	20	260.8	50	6	2.39	0.009	0.057	600
19	JV018	Horwarable HDW	HDW	Dhagahbur Town	Dhagahbur	2012/5/6	Alluvial	Ca-Mg-CO_3	43.57606	8.195358	4	3	0.006	0.056	144.5	0.175	27.86	1.187	550	741	7.72	1.112	35	246.4	46.83	63.03	5.57	0.009	0.094	850
20	JV019	Horadini HDW	HDW	Dhagahbur Town	Dhagahbur	2012/5/6	Alluvial	Ca-Mg-Cl	43.557712	8.209445	2	3	0.015	<0.005	173.5	0.222	5.04	1.137	714	2312.64	7.56	1.481	375	907.2	125.4	148.56	8.75	1.17	0.396	1410
21	JV020	Hormaan HDW	HDW	Dhagahbur Town	Dhagahbur	2012/5/6	Alluvial	Ca-Mg-Cl	43.556731	8.209776	2	5	0.351	0.223	148	0.14	2.94	1.371	556	2362.69	7.34	1.473	315	715.2	165.56	156.07	13.52	0.019	0.132	900
22	JV021	Horwaraable HDW	HDW	Dhagahbur Town	Dhagahbur	2012/6/6	Alluvial	Ca-Mg	43.570369	8.198087	2	3	0.005	<0.005	190.5	0.144	0	1.171	604	1032	7.31	0.78	110	344	86.19	84.04	3.98	0.066	0.245	550
23	JV022	Horwarable HDW	HDW	Dhagahbur Town	Dhagahbur	2012/6/6	Alluvial	Ca-Mg	43.570078	8.198285	2	4	0.004	0.059	186.2	0.148	0	1.154	404	1314	7.29	0.916	110	449.6	104.29	100.54	4.77	0.019	0.094	700
24	JV023	Horwarable HDW	HDW	Dhagahbur Town	Dhagahbur	2012/6/6	Alluvial	Ca-Mg-CO_3	43.563676	8.204104	18	3	0.243	0.213	173.2	0.121	0	1.12	856	1045	7.14	0.728	210	326.4	146.19	67.53	3.98	0.009	0.057	730
25	JV024	Horwarable HDW	HDW	Dhagahbur Town	Dhagahbur	2012/6/6	Alluvial	Ca-Mg-SO_4	43.569335	8.200236	2	3	0.006	0.098	195.3	0.043	2.65	1.087	674	884	7.55	1.116	80	372.8	63.33	67.53	3.98	0.009	0.34	690
26	JV025	Hormaan HDW	HDW	Dhagahbur Town	Dhagahbur	2012/6/6	Alluvial	Ca-Mg-Cl	43.557583	8.209833	4	2	0.104	1.634	157.5	0.307	59	1.003	710	2943	7.02	1.949	495	1102.4	154.44	190.58	10.34	1.783	0.189	1760
27	JV026	Hormaan R/Bed	HDW	Dhagahbur Town	Dhagahbur	2012/6/6	Alluvial	Ca-Mg	43.556949	8.209623	2	1	0.005	0.066	169.3	0.23	44.17	0.937	806	3023.45	7.64	0.808	105	548.8	101.59	76.53	2.39	0.198	0.34	650
28	JV027	Towlane Res	Treatment	Dhagahbur Town	Dhaghbur	2012/4/6		Na-Ca-Mg-HCO_3-CO_3	43.521399	8.242726113	4	7	0.005	0.091	168	0.113	0	1.271	396	1229	8	0.854	60	123.2	70.63	175.58	7.16	0.019	0.038	480
29	JV028	Towlane BH3	BH	Dhagahbur Town	Dhagahbur	2012/6/6	Basalt	Mg-Ca-Na-HCO_3-CO_3-SO_4	43.516572	8.235564	4	5	0.032	0.366	163	0.195	47.52	1.104	744	984	7.75	0.716	55	115.2	75.56	130.56	7.95	0.047	0.264	790
30	JV029	Horwarable HDW	HDW	Dhagahbur Town	Dhagahbur	2012/6/6	Alluvial	Ca-Mg-CO_3-Cl	43.573028	8.198133	6	1	0.135	0.171	161.2	0.132	68	1.187	790	1187	7.02	0.832	185	366.4	157.94	87.04	5.57	0.009	0.057	920
31	JV030	Horwarable HDW	HDW	Dhagahbur Town	Dhagahbur	2012/6/6	Alluvial	Ca-Mg-Cl	43.565086	8.2007	2	5	0.531	0.16	148.8	0.237	2.52	1.137	502	1551.77	7.55	1.131	275	504	134.29	105.05	6.36	0.066	0.057	1110
32	JV031	Haro-Yusuf HDW	HDW	Dhagahbur Town	Dhagahbur	2012/6/6	Alluvial	Ca-Mg-Na-Cl	43.552134	8.213458	4	5	0.056	0.08	141.2	0.148	12.95	1.238	1090	2963.38	7.26	1.681	550	811.2	168.1	219.1	24.65	0.038	0.17	1450
33	JV032	Haro-Yasuf-HDW	HDW	Dhagahbur Town	Dhagahbur	2012/6/6	Alluvial	Ca-Mg-Na-Cl	43.551577	8.214197	6	6	0.004	0.052	125	0.171	0.49	1.405	3000	2713.09	7.36	1.546	400	488	166.03	238.6	15.11	2.17	0.189	1180
34	JV033	Hodale HDW	HDW	Hodaale	Dhagahbur	2012/7/6	Alluvial	Ca-Mg	43.647643	7.928164	2	3	0.005	0.021	206.8	6.681	9.74	1.087	634	2382.72	7.74	1.996	165	1422.4	153.65	142.56	10.34	0.094	0.132	1570
35	JV034	Hodale HDW2	HDW	Hodaale	Dhagahbur	2012/7/6	Alluvial	Ca-Mg	43.647687	7.928698	2	4	0.005	<0.005	202.3	0.078	0	1.171	702	2112.41	7.28	1.811	120	1139.2	151.11	118.55	8.75	0.028	0.075	1520
36	JV035	Hodaale HDW3	HDW	Hodaale	Dhagahbur	2012/7/6	Alluvial	Ca-Mg	43.647967	7.929024	2	5	0.644	0.206	178.7	0.074	0	1.187	694	2392.73	7.24	2.142	175	1297.6	150.79	129.06	8.75	0.075	0.075	1740
37	JV036	Hodaale HDW3	HDW	Hodaale	Dhagahbur	2012/7/6	Alluvial	Ca-Mg-HCO_3	43.648021	7.929088	2	13	0.144	0.129	97.5	0.082	12.29	1.154	948	2492.84	7.3	2.159	140	1235.2	149.52	135.06	7.95	0.132	0.094	1650
38	JV037	Sasabane HDW	HDW	Sasabane	Dhagahbur	2012/7/6	Alluvial	Ca-Mg	43.668978	7.868204	4	2	0.005	0.31	104.3	7.961	5.75	1.271	606	2302.63	7.46	2.085	120	1300.8	152.22	118.55	10.34	0.028	0.094	1860
39	JV038	Bake BH	BH	Baka	Birkot	2012/7/6	Hamanlei	Ca-Mg	43.721398	7.761365	6	2	0.071	0.341	242	0.082	0	1.204	138	1473	7.68	1.25	170	654.4	217.46	115.55	6.36	0.009	0.038	680
40	JV039	Birkot BH1	BH	Birkot Town	Birkot	2012/7/6	Hamanlei	Mg-Ca-HCO_3	43.773447	7.602069	4	9	0.006	0.181	130.2	1.241	2.49	0.953	616	761	7.7	1.465	40	184	140.16	84.04	3.18	0.019	0.132	720
41	JV040	Birkot BH2	BH	Birkot Town	Birkot	2012/7/6	Hamanlei	Ca-Mg-Na-Cl	43.776495	7.620409	6	4	0.286	0.23	198.4	0.44	44.73	1.84	180	2002.28	7.4	1.724	480	516.8	211.9	202.59	7.16	0.028	0.094	790
42	JV041	Birkot Res	Treatment	Birkot Town	Birkot	2012/7/6		Mg-Ca-CO_3	43.773238	7.602186	6	5	0.322	0.23	222.8	1.117	0	1.037	102	798	8.11	1.402	95	305.6	203.49	78.03	3.98	0.009	0.038	300
43	JV042	Gomar BH	BH	Gomar	Shaygosh	2012/7/6	Hamanlei	Ca-Mg-Cl	43.812679	7.481253	2	7	0.009	<0.005	176.4	0.973	76	1.622	350	3123.56	7.65	2.632	725	926.4	217.46	234.1	12.72	0.085	0.811	1520
44	JV043	Shagosh BH	BH	Shaygosh town	Shagosh	2012/7/6	Hamanlei	Ca-Mg-Cl	43.919554	7.406424	4	3	0.006	0.3	223.2	1.809	8.77	1.723	360	1762.01	7.95	1.521	365	523.2	216.19	168.07	11.93	0.019	0.057	720
45	JV044	Wijiwaji BH	BH	Wijiwaji	Shaygosh	2012/8/6	Hamanlei	Ca-Mg-Na-Cl	44.09884	7.223387	2	6	0.393	0.08	188.8	2.689	3.38	0.886	336	3123.56	7.31	2.653	595	840	157.78	243.11	23.86	0.019	0.057	1460
46	JV045	Galadid BH	BH	Galadid	Kabridahar	2012/8/6	Hamanlei	Ca-Mg-Na-Cl	44.161014	7.071279	4	5	0.033	0.087	207.6	1.809	0.38	0.819	556	3223.68	7.28	2.932	730	894.4	159.37	252.11	21.47	0.028	0.057	1460
47	JV046	Karinbilcinle BH	BH	Karinbilcinle	Kabridahar	2012/8/6	Kabridahar	Ca-Mg-Cl-CO_3	44.231686	6.90269	12	3	0.004	0.077	163.2	1.086	0.46	0.953	88	4284.89	7.39	3.545	930	872	218.1	259.61	21.47	0.028	0.113	1590
48	JV047	Kabridahar BH1	BH	Kabridahat Town	Kabridahar	2012/8/6	Kabridahar	Ca-Mg-Na-Cl	44.282694	6.735313	6	5	0.109	0.289	141.3	1.813	1.28	1.171	2580	2212.52	7.29	1.987	455	534.4	155.87	207.09	15.9	0.028	0.038	1000
49	JV048	Kabridahar BH2	BH	Kabridahat Town	Kabridahar	2012/8/6	Kabridahar	Ca-Mg-Na-Cl	44.269008	6.720965	8	3	0.619	0.007	215.6	2.128	0	1.154	286	3123.56	7.43	2.535	675	739.2	215.24	325.64	31.01	0.019	0.075	1350
50	JV049	Kabridahar BH3	BH	Kabridahat Town	Kabridahar	2012/9/6	Kabridahar	Mg-Ca-Na-Cl	44.274913	6.747513	<0.9	4	0.084	0.129	200	1.607	0	1.304	1832	2072.36	7.5	1.637	340	288	215.08	195.09	15.9	0.019	0.057	880
51	JV050	K/Dahar HDW1	HDW	Kabridahat Town	Kabridahar	2012/9/6	Alluvial	Ca-Na-Mg-Cl	44.277893	6.745346	4	6	0.004	0.394	205.8	7.027	1.38	1.355	892	3654.17	7.33	3.33	705	680	158.1	307.63	28.63	0.019	0.057	1620
52	JV051	K/Dahar HDW2	HDW	Kabridahat Town	Kabridahar	2012/9/6	Alluvial	Ca-Mg-Na-Cl	44.278536	6.744768	6	2	0.113	0.338	191.2	1.412	0	1.254	266	3794.33	7.52	3.287	875	764.8	218.1	330.14	25.45	0.019	0.057	1430
53	JV052	K/Dahar HDW3	HDW	Kabridahat Town	Kabridahar	2112/9/6	Alluvial	Ca-Mg-Na-Cl	44.284619	6.743158	4	4	0.043	0.077	204.4	1.467	0.39	1.656	46	3113.55	7.59	2.599	710	665.6	219.68	270.12	19.09	0.006	0.088	1180
54	JV053	K/Dahar Res	Treatment	Kabridahat Town	Kabridahar	2012/9/6		Ca-Mg-Na-Cl	44.277074	6.736046	4	3	0.005	0.101	178	1.572	0	1.137	300	2132.47	7.72	1.991	455	534.4	155.08	211.59	15.9	0.009	0.057	1250
55	JV054	Dalad HDW	HDW	Dalad	Kabridahar	2012/10/6	Alluvial	Ca-Mg	44.11548	6.624454	2	3	0.119	0.059	146.5	4.175	0	1.171	1068	2282.6	7.02	1.952	105	1222.4	147.46	66.03	22.27	0.028	0.151	1950
56	JV055	Kabtinag HDW	HDW	Kabtinag	Kabridahar	2012/10/6	Alluvial	Ca-Mg-Cl	43.924275	6.579478	6	3	0.364	0.105	155.6	0.77	10.73	1.171	58	4074.65	7.33	3.716	440	1217.6	161.9	253.61	24.65	1.585	0.094	2080
57	JV056	Lasdhankeyrle HDW	HDW	Lasdhankeyrle	Kabridahar	2012/10/6	Alluvial	Ca-Mg-Cl	43.81938	6.560384	2	2	0.006	<0.005	115.5	2.428	0.23	0.97	950	2913.32	7.44	2.525	500	1091.2	151.43	135.06	7.95	0.019	0.094	2000
58	SB001	Danbarweyne HDW	HDW	Danbarweyne	Danan	2012/10/6	Alluvial	Ca-Mg	43.632704	6.517993	2	1	0.113	0.143	230.4	7.988	1.27	1.789	182	2012.29	7.55	1.646	100	1284.8	201.75	31.51	7.95	0.009	0.057	1400
59	SB002	Koore HDW1	HDW	Koore	Danan	2012/11/6	Alluvial	Ca	43.412716	6.551983	2	3	0.247	0.341	100.2	<0.017	7.59	0.719	928	1721.96	7.24	1.482	50	1259.2	86.35	36.02	14.31	0.028	0.151	1390

Data 1.3.1 : Result of Water Quality Analysis (2/2)

S/No	Code	Site	Source Type	Kebale	Woreda	Date	Geology	W type	Longitude	Latitude	CO_3 (meq/l)	HCO_3 (meq/l)	T.P(ppm)	NH_4 (ppm)	SO_4 (ppm)	NO_3 (ppm)	Turbidity(FTU)	F (mg/l)	TSS (mg/l)	TDS(ppm)	pH	EC(mS/cm)	Cl (ppm)	Ca(ppm)	Mg(ppm)	Na(ppm)	K(ppm)	Mn(ppm)	Fe(ppm)	Hardness (mg/l $CaCO_3$)
WHO		Guideline Value														50		1.5										0.4		
		Acceptable Value												1.5	250		5			1000			250			200		0.1	0.3	
Ethiopia														2	483	50		3.0		1776	6.5-8.5		533			358		0.13	0.4	392
60	SB003	Koore HDW2	HDW	Koore	Danan	2012/11/6	Alluvial	Ca-Mg	43.414181	6.554763	2	3	0.005	0.143	105.3	0.868	0.4	0.786	1078	1862.12	7.52	1.613	45	1296	144.13	37.52	7.95	0.019	0.132	1550
61	SB004	Danan HDW	HDW	Danan Town	Danan	2012/11/6	Alluvial	Ca	43.496399	6.510506	2	6	0.176	0.091	139.7	5.265	72	0.753	776	2482.83	7.22	2.288	290	1414.4	153.49	130.56	23.86	0.038	0.038	1780
62	SB005	Hadhawe HDW	HDW	Hadhawe	Gode	2012/11/6	Alluvial	Ca-Mg-Cl	43.603648	6.242139	2	3	0.096	0.209	181.6	7.179	1.1	0.886	356	3844.39	7.01	3.255	850	1368	219.37	249.11	14.31	0.019	0.057	1960
63	SB006	Gode Intake (River)	RIVER	Gode Town	Gode	2012/11/6		Ca-Mg	43.54671	5.923539	<0.9	2	0.218	0.164	135.2	1.019	449	0.719	58	529	7.93	0.609	50	366.4	104.29	48.02	3.98	0.009	0.17	570
64	SB007	River	RIVER	Gode Town	Gode	2012/11/6		Ca-Mg	43.544797	5.926446	2	2	0.046	0.293	96.3	1.148	556	0.702	1534	480	7.81	0.667	60	195.2	30	46.52	3.18	0.009	0.075	360
65	SB008	River	RIVER	Gode Town	Gode	2012/11/6		Ca-Mg-SO_4	43.539968	5.928875	2	2	0.067	0.111	170.8	0.938	541	0.686	1296	496	7.14	0.624	50	324.8	89.37	31.51	3.98	0.009	0.17	120
66	SB009	River	RIVER	Gode Town	Gode	2012/11/6		Ca-Mg-HCO_3	43.541538	5.932949	2	3	0.67	0.199	90.3	1.101	509	0.719	1378	507	7.77	0.682	65	200	36.98	46.52	3.18	0.019	0.151	460
67	SB010	Clear Water Gode	Treatment	Gode Town	Gode	2012/11/6		Ca-Mg	43.547613	5.923804	2	2	0.003	0.052	80.3	0.848	31.05	0.702	762	474	7.75	0.621	65	219.2	34.13	45.02	3.18	0.009	0.057	4800
68	SB011	Agriculture Tap Water Gode	Treatment	Gode Town	Gode	16/6/2012		Ca	43.559128	5.938023	2	2	0.042	0.174	220.8	1.14	0	0.786	200	600	7.74	0.863	55	1363.2	98.41	55.52	3.98	0.009	0.038	480
69	SB012	Agriculture Clear Water	Treatment	Gode Town	Gode	16/6/2013		Ca	43.552131	5.922983	2	3	0.211	0.164	90.8	0.852	6.89	0.786	576	566	7	0.775	55	400	22.7	48.02	2.39	0.009	0.075	900
70	SB013	Agriculture Intake (River)	RIVER	Gode Town	Gode	16/6/2014		Ca-Mg-CO_3	43.551157	5.922275	4	1	0.003	0.108	166	0.844	391	0.702	366	497	7.73	0.651	60	324.8	90.79	36.02	3.98	0.009	0.208	190
71	SB014	Kalafo Intake (River)	RIVER	Kalafo Town	Kalafo	16/6/2015		Ca-Mg	44.199961	5.587188	2	2	0.126	0.087	194	1.634	128	0.786	160	592	7.66	0.815	65	411.2	105.24	40.52	4.77	0.009	0.113	190
72	SB015	Kalafo Clera Water	Treatment	Kalafo Town	Kalafo	2012/12/6		Ca-Mg	44.201043	5.588718	<0.9	3	0.004	0.125	164.4	2.405	32.05	0.786	13336	618	8	0.687	45	401.6	97.78	60.03	4.77	0.009	0.057	390
73	SB016	Kalafo Tap Water	Treatment	Kalafo Town	Kalafo	2012/12/6		Ca-Mg	44.202986	5.533606	<0.9	3	0.444	0.373	151.2	1.276	80	0.803	162	597	7.74	0.787	55	406.4	97.46	40.52	3.18	0.009	0.094	560
74	SB017	River	RIVER	Kalafo Town	Kalafo	13/6/2012		Ca-Mg-SO_4 -HCO_3	44.196263	5.591615	2	3	0.006	0.181	150.8	1.475	541	0.753	2244	543	7.75	0.771	65	252.8	41.75	51.02	3.18	0.009	0.075	370
75	SB018	River	RIVER	Kalafo Town	Kalafo	13/6/2012		Ca-Mg	44.192596	5.592361	2	1	0.021	0.348	173.6	1.471	615	0.753	4818	571	7.66	0.78	45	377.6	97.62	40.52	3.98	0.009	0.17	230
76	SB019	River	RIVER	Kalafo Town	Kalafo	13/6/2012		Ca-Mg-SO_4	44.18262	5.59858	2	2	0.029	0.244	171.2	1.572	560	0.769	2352	607	7.79	0.934	105	291.2	55.56	52.52	3.18	0.009	0.321	700
77	SB020	Kalafo HDW	HDW	Kalafo Town	Kalafo	13/6/2012	Alluvial	Ca-Na-Mg-Cl	44.199758	5.590951	<0.9	2	0.017	0.376	130	0.479	1.99	1.104	148	7858.96	7.77	7.583	855	892.8	217.14	589.76	13.52	0.019	0.113	1800
78	SB021	Mustahil Intake (River)	RIVER	Mustahil Town	Mustahil	14/6/2012		Ca-Mg	44.733867	5.241222	2	2	0.234	0.24	171.6	1.319	725	0.769	2184	617	7.61	0.904	70	419.2	102.22	43.52	3.98	0.009	0.094	260
79	SB022	Mustahil Clear Water	Treatment	Mustahil Town	Mustahil	14/6/2012		Ca-Mg	44.733759	5.241539	2	3	0.004	0.376	150.4	0.86	3.17	0.769	190	703	7.59	1.118	60	476.8	110.63	43.52	4.77	0.009	0.019	300
80	SB023	Mustahil Tap Water	Treatment	Mustahil Town	Mustahil	14/6/2012		Ca-Mg	44.733759	5.241684	2	2	0.042	0.352	130.4	1.21	18.56	0.769	116	696	7.72	1.214	70	342.4	54.13	51.02	3.98	0.009	0.057	400
81	SB024	River	RIVER	Mustahil Town	Mustahil	14/6/2012		Ca-Mg-SO_4	44.733516	5.239476	2	2	0.18	0.178	168.8	1.323	758	0.753	518	620	7.76	0.985	50	284.8	48.57	57.02	3.18	0.009	0.132	460
82	SB025	River	RIVER	Mustahil Town	Mustahil	14/6/2012		Ca-Mg-SO_4	44.73155	5.23725	2	1	0.006	0.15	190.4	1.179	682	1.706	3150	636	7.81	0.958	75	369.6	100.79	43.52	3.98	0.019	0.151	340
83	SB026	River	RIVER	Mustahil Town	Mustahil	14/6/2012		Ca-Mg	44.716185	5.230938	2	2	0.004	0.199	180.4	1.23	716	0.753	4500	624	7.62	0.91	70	436.8	99.68	40.52	3.98	0.009	0.132	240
84	SB027	Kunaso HDW	HDW	Kunaso	Mustahil	15/6/2012	Alluvial	Ca-Mg-Cl	44.606927	5.353248	4	3	0.006	0.132	179.2	0.58	18.23	0.753	72	2482.83	7.27	2.148	340	296	155.56	100.54	7.95	0.019	0.075	1740
85	SB028	Adadle HDW1	HDW	Adadle	Adadle	17/6/2012	Alluvial	Mg-Ca-Na-Cl	43.532625	5.793873	4	1	0.006	0.038	170.8	0.125	2.84	0.886	214	2412.75	7.31	2	240	251.2	212.06	129.06	8.75	0.019	0.057	1690
86	SB029	Adadle HDW2	HDW	Adadle	Adadle	17/6/2012	Alluvial	Mg-Ca-Na-Cl	43.531503	5.798347	<0.9	3	0.004	0.038	176.4	1.763	22.66	0.87	72	2542.9	7.3	2.13	280	172.8	212.86	142.56	11.13	0.019	0.057	1820
87	SB030	Gode Tap Water	Treatment	Gode Town	Gode	17/6/2012		Ca-Mg	43.553524	5.956683	2	3	0.004	0.073	139.6	0.79	45.89	0.719	684	639	8	0.617	80	747.2	96.98	51.02	3.18	0.009	0.075	280
88	SB031	River	RIVER	West-Ime	West Ime	20/6/2012		Mg-Ca-CO_3	42.147159	6.456044	4	1	0.225	0.07	151.6	0.572	765	1.84	4468	592	7.68	0.52	10	169.6	173.02	48.09	10.62	0.017	0.618	270
89	SB032	River	RIVER	West-Ime	West Ime	20/6/2012		Mg-Ca-CO_3 -SO_4	42.147574	6.459326	8	1	0.152	0.261	178.8	0.525	844	1.789	3090	278	7.63	0.521	30	134.4	138.1	26.23	6.07	0.011	0.471	350
90	SB033	River	RIVER	West-Ime	West Ime	20/6/2012		Mg-Na-Ca-Cl-HCO_3	42.134201	6.471421	4	7	0.005	0.146	167.6	0.058	0.24	1.84	132	2002.28	7.83	2.18	395	168	234.13	214.21	39.43	0.017	0.794	500
91	SB034	Bula BH	BH	Bula	West Ime	20/6/2012	Alluvial	Mg-Ca-CO_3	41.021327	7.510862	4	2	0.009	0.3	135.6	0.518	702	1.739	5418	275	7.74	0.493	40	139.2	142.86	26.23	6.07	0.023	0.5	570
92	SB035	Raaso BH	BH	Raaso	Raaso	20/6/2012		Mg-Ca-Na-Cl	41.020153	7.312984	6	5	0.017	0.213	164	0.019	2.22	1.789	182	1409	7.93	1.896	485	217.6	237.62	205.46	48.53	0.011	0.235	680
93	SB036	Raaso HDW	HDW	Raaso	Raaso	20/6/2012	Alluvial	Ca-Mg-Cl	41.795044	6.530456	4	2	0.087	0.268	189.2	0.054	50	2.007	50	2633	7.73	2.406	335	878.4	253.49	134.06	18.96	0.011	0.235	1770
94	SB037	River	RIVER	East-Ime	East Ime	22/6/2012		Mg-CO_3 -HCO_3	42.166848	6.449982	8	5	0.03	0.129	154.8	0.362	420	1.773	1576	271	7.96	0.485	50	129.6	145.24	27.69	6.82	0.011	0.294	350
95	SB038	River	RIVER	East-Ime	East Ime	22/6/2012		Ca-Mg-SO_4	42.165862	6.450122	2	1	0.005	0.056	158	0.389	535	1.773	1534	289	8.02	0.492	45	129.6	127.78	24.77	6.82	0.011	0.353	260
96	SB039	River	RIVER	East-Ime	East Ime	22/6/2012		Ca-Mg-SO_4	42.168339	6.449792	2	2	0.13	0.303	144	0.424	444	2.141	918	267	8.03	0.482	15	126.4	134.6	27.69	6.07	0.011	0.647	340
97	SB040	River	RIVER	East-Ime	East Ime	22/6/2012		Mg-CO_3 -SO_4	42.168737	6.449677	4	2	0.082	0.091	148.4	0.385	543	1.706	1726	415	7.78	0.48	45	116.8	129.84	24.77	5.31	0.023	0.471	410
98	SB041	Laab HDW1	HDW	Laab	Borano	22/6/2012	Alluvial	Ca-Mg-Na-Cl	42.554436	6.209163	4.1	5.95	0.035	1.958	128	1	619	1.003	3106	6467.38	7.2	6.144	1095	587.2	245.87	308.93	73.55	2.529	0.765	3890
99	SB042	Laab HDW2	HDW	Laab	Borano	22/6/2012	Alluvial	Ca-Mg	42.552088	6.217079	1	2.5	0.006	0.15	179.2	0.047	2.77	1.739	196	1932.2	7.22	1.748	110	827.2	227.94	52.46	10.62	0.04	0.412	1620
100	SB043	Biroleys HDW1	HDW	Biroleys	Adadle	26/6/2012	Alluvial	Ca-Mg-Cl	43.402989	5.654632	2	4	0.006	0.341	182.8	0.144	12.91	1.672	280	1490	7.31	1.371	290	524.8	196.83	102	14.41	0.075	0.294	830
101	SB044	Biroleys HDW2	HDW	Biroleys	Adadle	26/6/2012	Alluvial	Ca-Mg-Na-Cl	43.385131	5.678248	2	6	0.005	0.206	140.8	0.117	3.63	1.957	616	4405.02	7.25	4.049	735	748.8	241.9	260.84	21.99	<0.01	0.294	2350
102	JICA BH1	BH1	BH		Kabribayah		Hamanlei	Ca-Mg-Cl	43.00874	9.0435	5	3	0.006	0.181	150.8	1.475	541	0.753	2244	543	7.75	0.771	65	252.8	41.75	51.02	3.18	0.009	0.075	370
103	JICA BH2	BH2	BH		Kabribayah		Hamanlei	Ca-Mg-Cl	43.00538	9.0420	5	3	0.006	0.15	190.4	1.179	682	1.706	3150	636	7.81	0.958	75	269.6	100.79	43.52	3.98	0.019	0.151	340

Note: The result of No.102 & No.103 is from JICA wells No.1 and No.2 drilled at Jarar valley.