**Oman Drilling Project – CM1A – Lead Scientist On-Site Log (LSOS).**

**15th November 2017 to 14th December 2017**

This is an electronic version of the blue on-site logbook.

**CM1 22.90726ºN, 58.33582ºE, Altitude 694 m (±? m) based on multiple waypoint averaging on DT’s GPS**

Hole CM1A. Inclined at 61º ± 2º, trend: 000 ± 2º

***Overview***

**CM1A oriented N-S – trending ‘000’ Planned.**

**DT (Damon Teagle) measured inclination as 29º / 61º. GC (Georges Ceuleneer) and ET (Eiichi Takazawa) agreed.**

**Remeasured trend GC, ET, DT – 179/359 – 000±1º = OK.**

**Angle between drill core and layering ~ 15º.**

**DAILY UPDATES**

**15th November 2017, Wednesday**

**On-site: JMM, DT, ET, YT, KM, GC, TS, KI, DM, JC, NW**

**LSOS: Juerg Matter, Damon Teagle, Eiichi Takazawa**

Started drilling Hole CM1A

Arrived on site: 06:50

Rig started: 08:10 then off. 08:55 on and lifted first rod. Finished set up. Restart 10:02

Rotation started:

Following 3 days of slow set up.

3 water tanks & 2 deep pits. Same EZ-mud & EZ-mud DP additives as last year.

SPUD IN CM1A @ 10:08 15/11/17. 1st ROTATION of PHASE II

ALL HQ RODS SHOULD BE 3m – DT CHECKED WITH WALI

After core 2Z, casing installed: HW casing – reaming with casing shoe. Incremental casing as at BT1 in Phase 1: “drill a bit, case a bit…” prevents deviation of HQ at top of hole.

CM1A 3M: Section 1 = ghost material fallen down during casing. Section 2 = new core, top of which shows cutting from drilling at base of CM1A\_2Z – offset ~18 mm.

Sketch

Summary of the day:

We started drilling on 15.11.2017! After a few meters of wadi gravels and highly fractured in – true gabbro with strong oxidation. Cores 6 & 7 were more coherent, robust and with sulphides. There are clear contacts between mafic and ultramafic layers and some other spots graduation between ultramafic and mafic cumulates. Several anorthosite layers, a few mm to 10 cm thick were observed. JMM

**16th November 2017, Thursday**

**On-site: JMM, DT, ET, YT, KM, GC, TS, KI, DM, JC, NW**

**LSOS: Juerg Matter, Damon Teagle, Eiichi Takazawa**

Arrived on site: 07:00

Rig started: already on when we arrived

Rotation started: 07:38

Rig paused after 15Z for drillers to have lunch.

Groundwater table ~20 m

15:45 Wali says water return is good (~70-75%)

JC noted dials on rig:

RSP (Rig System Pressure (kgcm-2)): ~130

PD (Pull Down (kgcm-2)): ~60

Left site: 17:40 (getting dark).

Summary of the day:

33 meters of mainly gabbro (olivine gabbro) drilled. Well developed graded bedding from melatroctolite or plagioclase wehrlite as well as anorthositic layers within the olivine gabbro were observed. JMM

**17th November 2017, Friday**

**On-site: JMM, DT, ET, YT, KM, GC, TS, KI, DM, JC**

**LSOS: Juerg Matter, Damon Teagle, Eiichi Takazawa**

Arrived on site: 08:00

No Drilling as Friday.

Summary of the day:

A day of catch-up with the drillers off for Friday. NW stayed in Ibra. Quiet without rig noise. DIS section unit description issues have been resolved and now logging with DIS again. We will work until we have 1 box at each station. KM training ET in curation. KM and DM off to Muscat tonight.

Katsu and Mori leave site for Muscat and return to Japan. DT, ET, YT, TS, KI, head to inspect GT1 & GT2 sites. Lock on GT1 damaged but not breached.

**18th November 2017, Saturday OMANI 47TH GLORIOUS NATIONAL DAY!**

**On-site: JMM, DT, ET, YT, GC, TS, KI, JC, NW**

**LSOS: Juerg Matter, Damon Teagle, Eiichi Takazawa**

Arrived on site: 07:00

Rig started: already started

Rotation started: already rotating when we arrived

Expect Anas Al Sulimani to arrive with his drone at 13:00.

-Drove flights over CM1 and some CM2.

Summary of the day:

33 meters of mainly olivine gabbro with thin layers of coarse-grained gabbro ~ pegmatite and minor amount of wehrlite or mela gabbro. Multiple fault zones occur within 3 meters, with an angle of 60º in the core reference frame. Vertical fracture is also developed in some zone (subvertical N-S fracture). [ET or YT?]

**19th November 2017, Sunday**

**On-site: JMM, DT, ET, YT, GC, TS, KI, JC, NW**

**LSOS: Juerg Matter, Damon Teagle, Eiichi Takazawa**

Arrived on site: 06:55

Rig started: Already started

Rotation started: 06:57

Summary of the day: Discussed water/mud return with Wali. Still 60-70% return. Was40-45% from 0-20m but then up to 60-70%. Water table at ≈ 20 m?

Drillers damaged wireline while pulling up the core barrel. They fixed it by cutting some single wires and by weaving others together again with a special tool. They were lucky and avoided to change large sections of wireline.

Final few sections (pm) much Ol-poor microgabbro. Good coring until last two cores – with four sections of highly disrupted fault zone. Fina 40 cm back into solid microgabbro. Fault zone into “body bags”.

JM returns to UK to write his proposal!

**20th November 2017, Monday**

**On-site: DT, ET, YT, GC, TS, KI, JC, NW**

**LSOS: Damon Teagle, Eiichi Takazawa**

Arrived on site: 06:54

Rig started:

Rotation started: 07:03

Summary of the day:

First will be short 0.50 m core.

Comments: Olivine Gabbro, Gabbro, Wehrlite (Ol + Cpx), Dunite (Ol), Anorthosite = Plagioclase

10:00 Said Al Manji and Khalid Al Rahbi from Ibra MRMWR office visited site. Requested start date, co-ordinates, info about drilling fluid and circulation. (~500 g EZ-Mud / 1000 L water)

Joined by Moe Kyaw and huge convoy of Lalbuksh trucks and rig to CM2 rotary site.

**21st November 2017, Tuesday**

**On-site: DT, ET, YT, GC, TS, KI, JC, NW, MK & engineer Takahashi Shokhiro (who has come to set up instruments on rotary rig)**

**LSOS: Damon Teagle, Eiichi Takazawa**

Arrived on site: 06:53

Rig started: already started

Rotation started: 07:05

Summary of the day:

61Z – New record 211 cm piece of gabbro core

Moe and Takahashi to rotary (CM2) site at 07:30 w/Jude. No Lalvol staff there yet so returned to CM1. Moe and Takahashi moved to CM2 again ~08:00 when Lalvol staff arrived.

63Z Bottom of core exploded out of barrel like a bullet – fault gouge.

Water recovery ~ 50%

-NB – Final 10 m took ~ 5 hours to drill.

**22nd November 2017, Wednesday**

**On-site: DT, ET, YT, GC, TS, KI, JC, NW, MK, TS II**

**LSOS: Damon Teagle, Eiichi Takazawa**

Arrived on site: 06:55

Rig started: already started

Rotation started: already started

Summary of the day:

Took microbio sample of gabbro from 62Z4, ~21cm (drilled previous day).

30 cm of back fill overnight.

Another explosive core. Installed wicket keeper tarp for the Wali Super Gun!! ☺ ☺

Slow difficult coring in fractured dunite. Highly fragmented cores and some sheared faultzones.

~14:00 – Eiichi left for airport, via Ibra for a shower

~16:00 – Wali says water return is ~60-50%

- Ran out of diesel for rig. Topped up and rig restarted.

Current drill bits are for hard formation – will trip out after 77Z & inspect bit in am.

**23rd November 2017, Thursday**

**On-site: DT, YT, GC, TS, KI, JC, NW (MK, TS II at rotary site)**

**LSOS: Damon Teagle**

Arrived on site: 07:10

Rig started: Already on

Rotation started: Drillers preparing to POOH to check bit so DT, JC & GC drove on to CM2 to check status – should spud in this am. DT, JC and GC watched spud in with MK and TS II at CM2A, 08:20. Returned to CM1A 08:45 – Wali and team are tripping out. YT, TS, KI continuing to process yesterday’s cores.

Summary of the day:

10:00 Changed bit – worn bit (Hardness 11) replaced by fresh bit (Hardness 7, as used at GT1A) – Both HQ.

Tripping back into hole.

JAC: Noticed that some inconsistency between defining pieces and subpieces – discussed with YT – agreed that henceforth curator should insert orange markers to denote different pieces, whenever possible rotation (i.e. red blue lines are not continuous) or discontinuity. So far in DIS, haven’t been recording “Sawn” as an option for continuity between sections… should start doing this.

13:00 Tripped pipe to replace hard formation bit (highly worn now with stumpy teeth and no grooves). Re-enter with softer formation bit (as described above).

Pipe trip in – smooth insertion of rods, no sticking to bottom of the hole.

13:30 High pressure observed; pulled out core barrel; re-inserted with same result. Core barrel pulled out of hole and trying to clean up the drill rod/bit to reduce the pressure and to ascertain that there is no blockage at the bottom before we actually re-start drilling.

14:50 Flushed again, re-insert final rods

**25th November 2017, Saturday**

**On-site: JC, YT, TS, KI, NW, JK (MK, TS II at CM2A)**

**LSOS: Jude Coggon**

Arrived on site: 07:02

Rig started: already started

Rotation started: 07:12

Summary of the day:

Fatna Kourim arrived from MCT ~12:20

New additional Site Geologist (GeoSolutions) today: Abdul Rasheed

More Dunite, becoming more competent towards the end of the day. Wehrlite in 85Z.

**26th November 2017, Sunday**

**On-site: JC, TS, KI, NW, JK, FK (MK, TS II at CM2A)**

**LSOS: Jude Coggon**

Arrived on site: 07:00

Rig started: already started

Rotation started: already started (~06:55)

Summary of the day:

Yoshi is ill so not on site today

More competent cores today, of dunite and wehrlite. Jürgen and Fatna settling into coreflow well.

**27th November 2017, Monday**

**On-site: JC, TS, KI, NW, JK, FK, YT (MK, TS II at CM2A)**

**LSOS: Jude Coggon**

Arrived on site: 07:05

Rig started: already started

Rotation started: already started

Summary of the day:

Corescanner is not communicating with computer this morning… have tried restarting everything, tried different USB cables from scanner to laptop – still not working: “Code 1, communication error” – scanner not initializing. Trying switch all off and wait 30 mins. Possible problem with port for this cable on back of scanner?

12:15 – JC drove out of wadi to get phone signal in order to email/call Ronald Conze. Spoke on phone – he has no other suggestions yet but will contact DMT and ask for advice.

**28th November 2017, Tuesday**

**On-site: JC, NW, JK, FK, YT, TS, KI (MK, TS II at CM2A)**

**LSOS: Jude Coggon**

Arrived on site: 06:57

Rig started: already started

Rotation started: 07:25

Summary of the day:

Backfill ~70 cm

JC tried uninstalling and reinstalling the scanner – still not recognized.

Still working on problem with scanner – seems to be less problematic when using a different USB port (still not initializing but not declaring a malfunction either). Waiting to hear advice from DMT.

Geology: More variably fractured dunites and wehrlites with occasional intrusions of gabbroic rocks. Beautiful textures at contacts.

**29th November 2017, Wednesday**

**On-site: JC, NW, JK, FK, YT, TS, KI**

**LSOS: Jude Coggon**

Arrived on site: 06:58

Rig started: already started

Rotation started: already started

Summary of the day:

11:00 Wali will POOH because: 1) need to check bit as pressure is very high; and 2) lots of fractured material higher up is pressing on drill string.

Need to POOH, check bit, clean hole and should be able to continue without casing, so continue drilling HQ.

~11:30 Sidney and Mazin arrived at CM1 – stayed around 20 mins then on to visit CM2.

~13:00 Completed POOH. Inspected bit – not very worn, still in good condition, but water channels blocked with clay/cuttings so need to unblock. Also removed and replaced stabilizer from inside bit (brass-coloured ring).

13:35 RIH team cleared (processed) full boxes. Used tablet to take flat box images for boxes 75 – 94.

17:15 Borehole collapsed from 196 m. Wali has reamed to 200 m now and will continue in morning. Expects to reach 274 m by 9 am.

**30th November 2017, Thursday**

**On-site: JC, NW, JK, FK, YT, TS, KI (MK at CM2)**

**LSOS: Jude Coggon**

Arrived on site: 08:03

Rig started: already on

Rotation started: Wali still cleaning hole. At 202 m. Void at ~ 200 m caused slow rate.

Summary of the day:

More suggestions from Ronald and DMT to try with scanner and PC.

Scanner fixed! Problem was loose USB cable connection to the camera itself. Time to catch up on scanning from last three days (around 15 boxes to W-R scan. 20 to flat scan). Yoshi, Tomo and Keisuke doing a fantastic job to get all cores scanned and flat images of boxes!

10:50 Now at 247 m. System pressure has reduced from ~200 to ~140 kg cm-2. Wali is much happier with this value.

14:40 5 m to go to get to bottom of hole.

17:00 Rig off. 1 m above bottom of hole. Sludge is not clearing well (density of circulating fluid is greater at bottom of hole than should be. Need to go slowly).

**2nd December 2017, Saturday**

**On-site: JC, NW, FK, KI, KO (MK at CM2A)**

**LSOS: Jude Coggon**

Arrived on site: 07:00

Rig started:

Rotation started:

Summary of the day:

JC ran DMT calibration procedure – will send files/images to RC tonight.

Still cleaning / reaming last meter of hole.

JC taught KO and KI to use core scanner for 360º + planar modes + white balance calibration. Showed KO coreflow as much as possible. KO and KI scanned box 95 (360º and flat images).

KI showed KO and FK how to sketch, using box 54 as example. FK briefly showed KO and KI the core description.

Update on hole: Wali’s notes from Thursday reaming and cleaning:

196 – 212 m collapsed

232 – 235 m cavity

247 – 250.25 m cavity

Struggling to get to bottom of hole – cuttings not clearing.

Wali proposes two options: POOH, then:

1. Cement entire hole. Wait 2 days for cement to harden. Estimated 4 days to drill through cement to bottom of hole (274.75 m). Then continue with HQ coring.
2. Case hole with HW casing and shoe bit (may take a day or more to get to bottom if collapsed zones cause issues again), then continue with NQ coring.

JC, NW and Wali discussed these options. NW asked Wali to drill to bottom of hole (final 1 m) and see if he can continue. If he can’t then we will go with option 2 – decision from JC as considered to be less risky as well as quicker 🡪 if we cement we will definitely not be able to log top of hole (to 275 m). If we case there’s still a chance to log part of the hole. Also, if re-drilling, chance of hole deviating (60% chance of deviation says Wali).

JC asked Wali and Abdul Rasak to send for NQ rods, bits, boxes, foam etc. now so that we can avoid further delays.

**3rd December 2017, Sunday**

**On-site: JC, FK, KI, KO, JMG (MK at CM2A) NW will come at lunchtime**

**LSOS: Jude Coggon**

Arrived on site: 08:10

Rig started:

Rotation started:

Summary of the day:

Drillers have brought NQ accessories + rods from Muscat and are preparing to POOH and step down.

FK, KO, KI, JMG going to walk up wadi to look at outcrops – Fatna & Keisuke will show new guys the interesting outcrops + features that they have observed previously.

JC staying on site to do some work and check if drillers need to discuss anything.

10:10 Khaliq, Sadiq and Mohammed spending the morning joining pairs of NQ drill rods and stacking up by rod slide. Abdul Rasheed is “supervising” aka. standing around doing nothing much at all. Wali and Abdul Rasak are not on site.

11:05 Shoe bit for NW casing fitted to HQ rods. New drill bit for NQ drilling fitted to NQ bottom hole assembly. JC has photo of both.

11:20 FK, KO, KI and JMG returned from their mini fieldtrip up the wadi.

11:35 Wali and Abdul Rasak arrived – Wali has been overseeing preparation of smaller size liners for NQ core rack.

11:42 Wali has rig ready to start POOHing – starting now.

~13:40 Jürg and Eiichi arrived.

16:20 Finished POOHing

16:44 Started re-entering with NW casing.

**4th December 2017, Monday**

**On-site: JMM, FK, KO, JMG, NW (MK at CM2A) ET, KI from airport at 10:30**

**LSOS: Juerg Matter**

Arrived on site: 08:30

Rig started:

Rotation started:

Summary of the day:

Drillers installed NW casing down to 150 m and continue to install NW casing after breakfast break 10:00.

JM & FK go to CM2A site for cuttings logging until 11:00. NW, JMG, KO stay at CM1A.

Drillers finished installation of NW casing to 272 m depth at 10:49.

HQ drill assembly was: 91 joints = 273 m

 Core barrel = 004.1 m

 Total = 277.1 m

Minus casing height at surface (1.85 m) = 275.25 m

NQ will be: 91 joints + core barrel (4.0 m) – casing height at surface (1.85 m)

So = 273 + 4 – 1.85 = 275.15 m

CM2A changed from hammer drill bit to rotary. Restarted drilling at 15:50 @ 218 m.

**5th December 2017, Tuesday**

**On-site: NW, JMM, MB, ET, FK, KO, JMG, KI (MK at CM2A)**

**LSOS: Juerg Matter & Eiichi Takazawa**

Arrived on site: 06:55

Rig started:

Rotation started:

Summary of the day:

10.6 m of mainly dunitic cores were recovered. Some troctolite in 122Z. Gabbro layers occur in 123Z – 124Z. Core recovery after 5 days of interruption changing from HQ to NQ core. Beautiful fresh euhedral olivines are abundant in 125Z. Dunites are frequently associated with fragmented zones and fault gouge (126Z).

Left site at 17:20

**6th December 2017, Wednesday**

**On-site: NW, JMM, MB, FK, KO, JMG (MK at CM2A) ET & KI at Police station in Ibra to extend KI visa – arrived onsite at 09:00**

**LSOS: Juerg Matter & Eiichi Takazawa**

Arrived on site: 06:45

Rig started: already started

Rotation started: already started (~06:35)

Summary of the day:

15:07 Bit jammed @ 285.0 m 🡪 pulled up the drill string by 18m for cleaning/flushing.

🡪 resumed drilling at 16:00 🡪 hole stable again.

10.3 m of mainly dunite were obtained. The cores are partially fractured in some depths. However, more dunites with fresh olivine crystals are increasing. 30 cm thick gabbro layers occur in 133Z. After cleaning of borehole and re-entry of pipes, 36 cm of dunite cores were recovered 1n 136Z. Very impressive dunites occur in 135Z. Many olivine crystals are visible in the surface of the wet core. These cores are recovered as continuous solid core. A few cm of serpentinite halos are also well-developed.

**7th December 2017, Thursday**

**On-site: NW, JMM, ET, KI, MB, FK, KO, JMG (KO goes to CM2 site at 07:45)**

**LSOS: Juerg Matter & Eiichi Takazawa**

Arrived on site: 06:45

Rig started:

Rotation started: 07:00

Summary of the day:

Core 142 was drilled as 3 m advance but some portion of the core not recovered so run in again the inner tube to catch the core unsuccessfully. Repeated the whole exercise yet again… and finally we have the core leftover in the hole on the deck @ 16:37. Drilling completed for now.

Finished at 17:00

14.5 m of dunite were recovered. Dunites are coarse granular and individual grains are visible on the core surface. They are mostly continuous having the longest piece of 105 cm in 140Z. Small amount of gabbro dyke (137Z) and some amount of plagioclase are aligned in some cores. Clinopyroxenes of ~1 mm occur at some cores. The core of 139Z were [brusted?].

**9th December 2017, Saturday**

**On-site: NW, JMM, ET, KI, MB, KO, JMG, HB (KO goes to CM2 site at 08:00) MB and MR coming from Muscat arrived @ 11:15 am at site**

**LSOS: Juerg Matter & Eiichi Takazawa**

Arrived on site: 06:45

Rig started:

Rotation started: 07:27

Summary of the day:

295 m small part collapsed while going down with the rods 🡪 fallen pieces

\*Water level measured by Wali is 2 m (?) NW casing & NQ drill string inside: should be measured again and authenticated once everything is out.

Finished at 17:30

21 m of dunite and harzburgite were recovered. The first harzburgite appeared in core 143Z. Most of the cores are continuous and some spectacular faults with serpentine were observed.

**10th December 2017, Sunday**

**On-site: NW, JMM, ET, KI, MB, MR, KO, JMG, HB (KO goes to CM2 site at 07:30)**

**JMM goes to Muscat at 08:00 [to collect Tomo from airport?]**

**LSOS: Juerg Matter & Eiichi Takazawa**

Arrived on site: 06:55

Rig started:

Rotation started: 07:19

Summary of the day:

21 m of mostly dunite was recovered today. The core conditions are really good to have two long pieved of 110 cm and 140 cm of dunite. The dunites are associated with irregular shaped white veins consists of alteration minerals including tremolite and sometimes diopside. Some of the dunites have opx-bearing short intervals to be named at harzburgite. The last core (156Z) are fragmented due to possible fracture zone of a few 10s of cm thick. Tomo found a possible chromitite pod (4cm thick) in the section 155-1.

**11th December 2017, Monday**

**On-site: NW, JMM, ET, KI, MB, MR, KO, JMG, HB, TM (KO goes to CM2 site at 08:00)**

**LSOS: Juerg Matter & Eiichi Takazawa**

Arrived on site: 06:50

Rig started:

Rotation started: 07:15

Summary of the day:

11:00 GUtech students visiting

18 m of dunite with white veins. Some harzburgites in the lower part. Fracture zone in 161Z and 158Z. Harzburgite started again from 160Z in which vertical dunite with white vein occurs in 160Z-3.

GUtech students visited the site. 4 groups visited in order. Juerg and Harry explained our objectives and the procedure to the students. Geology of Oman filmed interviews of some scientists asking particular questions in Earth Science and geology in Oman. Two small buses brought students to the site. Total 40 students.

**12th December 2017, Tuesday**

**On-site: NW, JMM, ET, KI, MB, MR, KO, JMG, HB, TM (KO goes to CM2 site at 08:00)**

**LSOS: Juerg Matter & Eiichi Takazawa**

Arrived on site: 06:55

Rig started:

Rotation started: 07:17

Summary of the day:

Harzburgite continued from 166Z with alternation of opx-poor part and dunite. Vertical fractures develop frequently in 167Z to 168Z with severe alteration. Some dunite with white patches and plagioclase occurs in 169Z-4. Fault gouges in 168-2 to 3. The sections 171-3 ~ 4 are severely altered with white veins in fractures.

Normal advance of expected core recovery (total 15 m).

**13th December 2017, Wednesday**

**On-site: NW, JMM, ET, KI, MB, MR, KO, JMG, HB, TM (KO goes to CM2 site at 08:00)**

**LSOS: Juerg Matter & Eiichi Takazawa**

Arrived on site: 06:40

Rig started:

Rotation started: 07:45

Summary of the day:

09:45 – 10:30 Visit of MRMWR representative ([Khalid?]) to CM1 + CM2

Harzburgite continued from 173Z to 179Z. Vertical fractures with serpentine and calcite mineralization throughout all cores today. Some alternation between quite fresh harzburgite and more altered harzburgite was observed. Some sections (176 - 178Z) show fine vein networks of serpentine and calcite.

[END OF HOLE! FINAL DEPTH 404.15 m]

**14th December 2017, Thursday**

**On-site: JMM, MB, MR, KO, JMG, HB, TM**

**LSOS: Juerg Matter**

Arrived on site: 08:30

Rig started:

Rotation started:

Summary of the day:

Wrapping up, characterizing and describing core 179Z from 13th December and preparing site for demobilization and mobilization to CM2B.

**16th December 2017, Saturday**

**On-site:**

**LSOS: Juerg Matter**

Arrived on site:

Rig started:

Rotation started:

Summary of the day:

Demobilization at CM1 and CM2.

We left site early because of big thunderstorm approaching the mountains.