Australian Aid

AMEP
Australia Mongolia Extractives Program

Advanced Training for CBM Geologists

Drilling Equipment Methods and Procedures

Ulaanbaatar, Mongolia

16 June 2022

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Cipher Doc#: 22-424

Schedule

Advanced Training for CBM Geologists

from	To	total time (hr:min)	Topic
9:00	**9:15**	**0:15**	**Opening Remarks & Introduction**
9:15	10:45	1:30	Origin of Reservoir Properties: from Peat to Pores
10:45	11:00	0:15	Questions/Discussion
11:00	11:15	0:15	Coffee Break
11:15	12:45	1:30	Unconventional Hydrocarbons and Geological Models
12:45	13:00	0:15	Questions/Discussion
13:00	**14:00**	**1:00**	**LUNCH**
14:00	14:45	0:45	CBM Drilling Equipment & Methods
14:45	15:00	0:15	Questions/Discussion
15:00	16:00	1:00	Coal & Rock Review - What and How to Characterise
16:00	16:15	0:15	Questions/Discussion
16:15	16:30	0:15	Coffee Break
16:30	17:30	1:00	Measuring Gas
17:30	18:00	0:30	Critical CBM Reservoir Properties: Know where to Place Your Efforts
18:00	18:15	0:15	Questions/Discussion
18:15	**18:30**	**0:15**	***Closing Remarks***

NOTE: Times are in UB, Mongolian Times

Purpose of drilling a CBM Exploration Well

- Obtaining core samples for analysis
- Permeability test gas bearing strata

Safety on a drill site

- All staff are responsible for their own safety
- Site induction will cover hazards, but hazards can appear at any time!
- Experience is very valuable- experienced staff need to mentor new staff
- Chris and Tim have worked on or around over 100 drillholes

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Safety on a drill site- key hazards

- Gas explosion/Gas-to-surface
- Heavy vehicle movement- trucks and telehandlers (forklifts)
- Trip hazards
- Suspended loads (typically drill rods and casing)

Drill sites are very dynamic and new hazards can develop at any time. Be alert for them!

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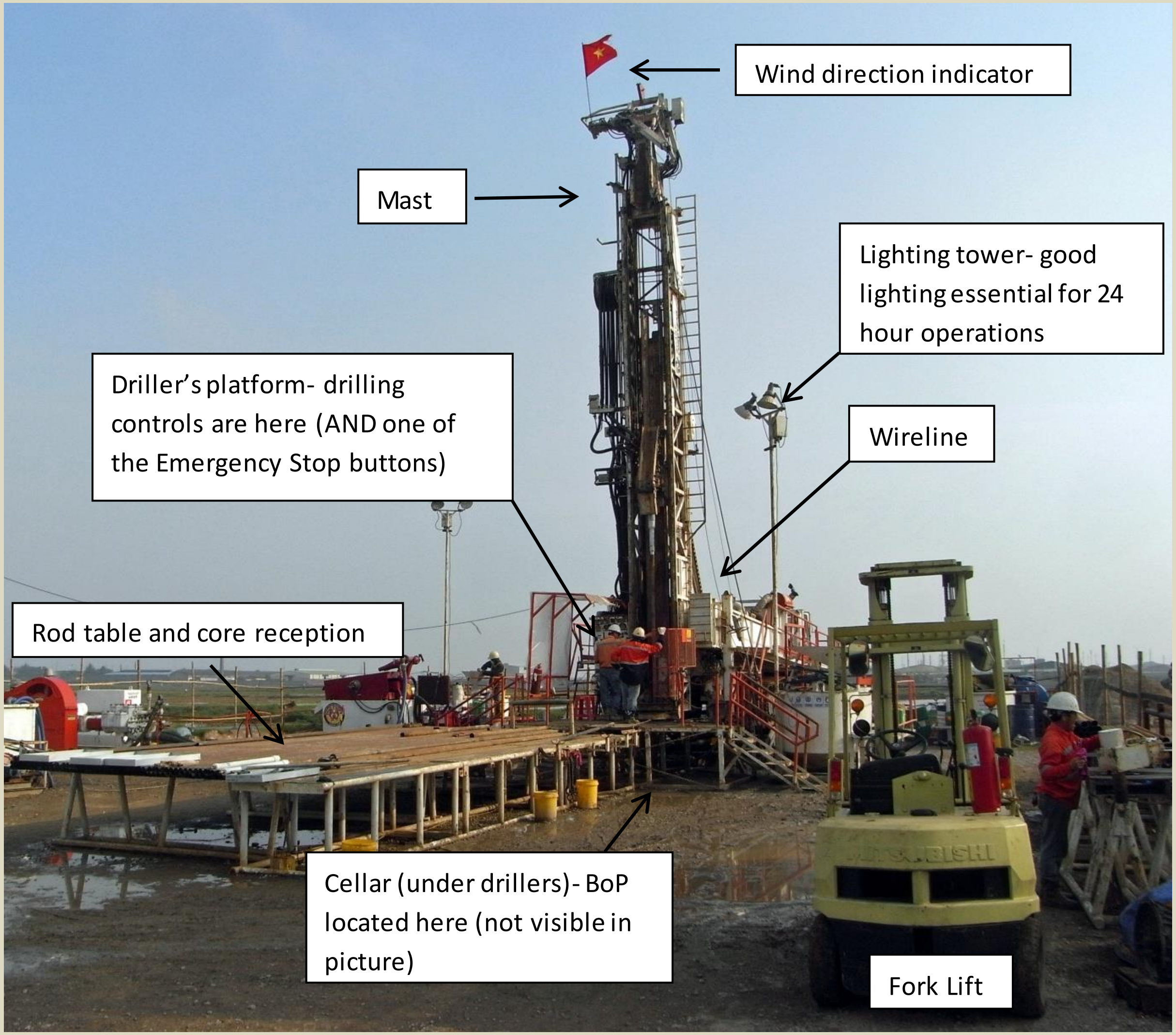
Equipment- Drill rigs come in all sizes

Equipment- Drill rig components



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Process

- Review existing data
- Create geological model
- Determine target zone (s)
- Create a well design
- Drill

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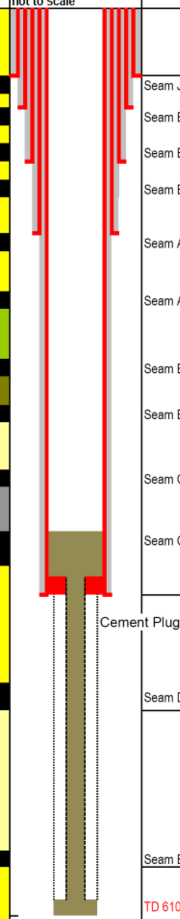
Well Design

General Information		
NO AFE	:	10-0001R2
Budget No.	:	USD 881,679.00
Well name	:	TECBM#P01-C
Field	:	Tanjung Enim
Work classification	:	Drilling
Classification	:	Exploration Core Well Completed as a piezometer
Surface Coordinate	:	
X	:	373204.96 mE
Y	:	9586037.01 mN
Long	:	103° 51' 29.44" E
Lat	:	3° 44' 40.03" S
Subsurface Coordinate	:	
X	:	373204.96 mE
Y	:	9586037.01 mN
Long	:	103° 51' 29.44" E
Lat	:	3° 44' 40.03" S
DF - Collar	:	
Collar elevation	:	96.00m
LBA Elevation	:	
Rig	:	TBA
TD plan	:	
mTVDSS	:	
mTVD	:	
mMD	:	
Main Prospect	:	
Additional Prospect	:	
Production Target	:	
BOPD	:	
MMSCFD	:	
Refernce well	:	
Spud in prediction	:	
Time to work	:	
R/M	:	
R/U	:	
DRL	:	
COMP	:	
R/D	:	

REVISED WELL DESIGN

FORMATION (not to scale): Sandstone, Sandstone, Sandstone, Sandstone, Sandstone, Sandstone, Mudstone, Siltstone, Clavey Sandstone, Carb Mst, Sandstone, Clayey Sandstone, SAndstone

Well Profile (not to scale)



	CASING DESIGN	BIT, BHA DESIGN	MUD DESIGN	CEMENTING DESIGN	BOP INSTALLED
		Excavator	NA	Ready Mix	NA
	0m - 6m 13 3/8" 54 ppf	Install as part of cellar construction	NA	14ppg portland	Washington Dirvertor
Seam J, 9 - ?m	0m - 15m 9 5/8" 36 ppf R1	12 1/4"pdc Near bit Stab 2x 6" dc; 8 1/2" rod line Stab	9.4 ppg WA 131 Pollemer Based	14ppg portland	13 5/8" Annular
Seam EN1, 18.37- 33.7m Seam EN2,48.90 - 54.90m (M3 unit)	0m - 50m 7" 26 ppf R1	8 1/2" pdc, Near bit Stab 2x 6" dc 8 1/2" rod line Stab	9.4 ppg WA 131 Pollemer Based	14ppg portland	13 5/8" Annular
Seam EN3, 78.57 - 85.17m (M3 unit)	0m - 150m 5 1/2" 20 ppf R1 FJ	6 1/8 pdc, near bit stab 2 x 4 3/4" dc 5 7/8" rod line Stab	9.4 ppg WA 131 Pollemer Based Lighten up to 10ppg, if mud loss occures	14ppg portland	7 1/16" Blind Shear 7 1/16" Annular
Seam A1, 165 - 175m (M2 unit) Seam A2, 179 - 190m (M2 unit) Seam B1, 206 - 219m (M2 unit) Seam B2, 232 - 233m (M2 Unit) Seam C1, 277 -290m (M2 unit) Seam C2, 326 - 337m (M2 unit)	0m - 415m 41/2" 9.5 ppf R1	3m PQ3 WL Core Barrell PQ3 Core bit HWT Drill pipe	9.4 ppg WA 131 Pollemer Based	14ppg portland	7 1/16" Blind Shear 7 1/16" Annular
Seam D, 439 - 442m (M1 unit) Seam E, 542 - 548m (M1 unit) TD 610		HQ3 WL Core Barrell PQ3 Core bit HWT Drill pipe	9.4 ppg WA 131 Pollemer Based Lighten up to 10ppg; if mud loss occures	NA	7 1/16" Blind Shear 7 1/16" Annular

Staged design, diameter decreases with depth

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Drilling procedures- Open hole

- Fast way of drilling- typically the top of drill hole will be drilled this way.
- Solid drill bits chip a hole through the rock
- Drilling fluid (mud) is circulated through the hole
- Rock chips return to surface in drilling fluid

Casing

Drilling Fluids

- Usually a polymer mud which is in a concentrated liquid form

  OR:

- Bentonite clay powder

Fluids are added to the mud pump and circulated in the drillhole. They affect the viscocity and weight of the drilling mud which is a valuable tool for drillers to maintain the drillhole

Mud Pumps

Low tech

High tech

Both get the job done

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Drilling Procedures- Cored Section

- In sample target zone, the drillhole will be cored, retrieving a cylinder of rock
- “Wireline” coring allows rapid retrieval of core from the bottom of the drillhole. The barrel of core can be lifted from the bottom of the hole without removing the drill rods or “rod string”
- A cutting bit, typically diamond impregnated, advances the hole and cuts a cylinder of rock which is left in the core barrel which can be winched to the surface using a “wireline”

Retrieving Core from Barrel

Core is pumped from tube once core catcher is removed

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Coring Bits

Different styles for different conditions

Core Sizes

As drillholes get deeper, it is often necessary to reduce the size of the coring bit to decrease the power demand on the rig and the torsional stress on the drill stream

Typical core sizes in CBM drilling are:

- PQ-PQ3 (Core Diameter 85-83mm, 3.35-3.27 inches)
- HQ-HQ3(Core Diameter 63.5-61.1mm, 2.50-2.41 inches)
- NQ-NQ3 (Core Diameter 47.6-45.0mm, 1.86-1.78 inches)

For sampling purposes- canisters need to have and internal diameter at least 10 mm greater than the diameter of the core

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Methods- Controlling Friction and Pressure

- Drilling very specialised. Main objective is to keep the rod string from getting stuck while drilling in a safe manner. Friction due to hole collapse increases with increasing surface contact, ie increases with depth unless cased
- Excessive torque on drill string can cause it to snap, resulting in lengthy “fishing” expeditions
- Casing, cementing problem sections, drilling muds minimise friction concerns
- Drilling for **gas** has specific safety concerns and mitigations- **well control** to regulate pressure

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Stabilising the drillhole

- CASING: As hole is drilled, steel rods are inserted into the ground to prevent collapse of the wall of the drill hole
- CEMENTING: Unstable sections of the hole can be filled with cement and subsequently drilled out
- DRILLING FLUIDS: Also called drilling mud. Mud forms a skin on the surface of the uncased section of hole which helps to prevent collapse

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Well Control

- Well control consists of two basic components: an active component consisting of drilling fluid pressure monitoring activities, and a passive component consisting of the blowout preventer or BOP

- The first line of defense in well control is to have sufficient drilling fluid pressure in the well hole. During drilling, underground fluids such as gas, water, or oil under pressure (the formation pressure) opposes the drilling fluid pressure (mud pressure). If the formation pressure is greater than the mud pressure, there is the possibility of a blowout. Annular pressure at the well head, mud density and viscocity need to be monitored constantly in CBM drilling operations

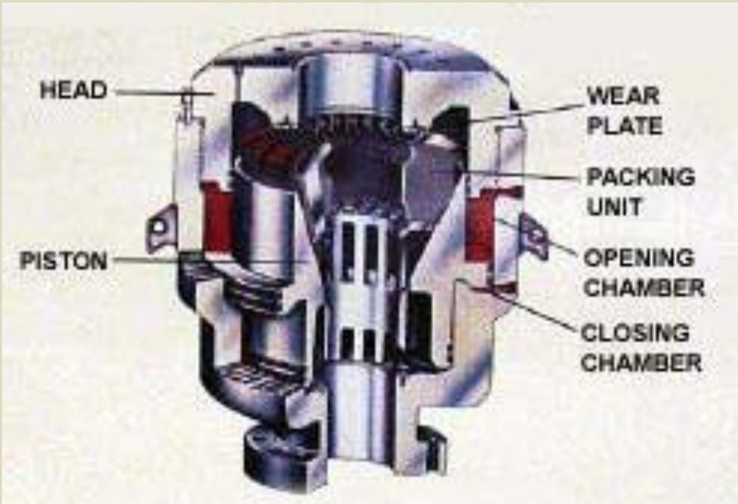
Blowout Preventers

In the event of a sudden, uncontrollable increase in annular pressure, the well head can be shut in by a blowout preventer (BOP).

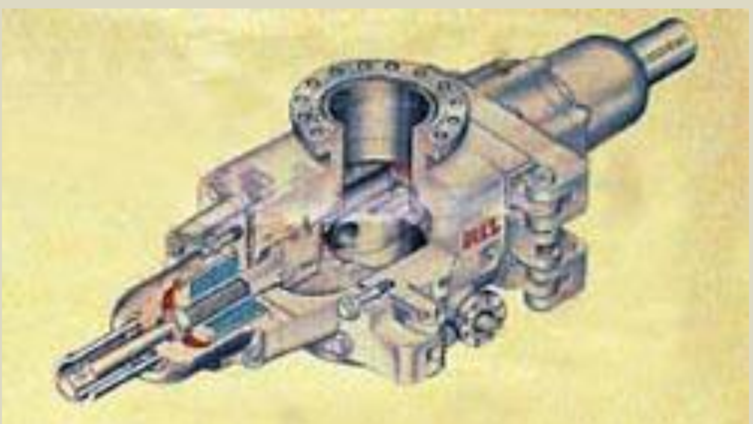
- BOP's are one or more valves installed at the wellhead which prevent the escape of pressure in the annular space between the casing and the drill pipe
- Annular blowout preventers
- Ram blowout preventer (last resort)
- Stack (combination of above two systems)

BOP Systems

Annular BOP



Ram BOP



BOP Stack with multiple rams

“Blooey Line”- gas diverter

Once the well is “shut in”, the gas can be diverted away from the rig via a “blooey line”. Upon opening a valve on the BOP the gas flows from the annulus to the. The discharge point of the blooey line is well away from drilling operations and sources of ignition

Blooey Line- trip hazard, but essential

Gas Detectors

Located at the well head and drilling platform
Calibrated regularly and “bump” tested daily- best practice

Need to detect:

- CH_4- Methane
- H_2S- Hydrogen sulphide
- CO- Carbon monoxide
- O_2- Oxygen

Calculate Lower Explosive Limits (LEL) and Upper Explosive Limits (UEL) on the basis of gases detected

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Gas Detectors- Typical hand held

BW Gas Alert Micro

Features:

- Multi Gas Detector
- Simultaneous display H_2S, CO, O_2 and combustibles (LEL)
- Rugged and not expensive

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What happens on a drill site

Long days & nights

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What happens on a drill site

Nothing…then a lot

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What happens on a drill site

Dangerous & dirty

What happens on a drill site

Many different activities

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What happens on a drill site

Unexpected events

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Duties and equipment

Job safety analysis & risk mitigation

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Duties and equipment

Setting up equipment & laboratory

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Duties and equipment

Checking that everything works

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Duties and equipment

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Project:

Hole:

	Date	Time Started Coring	Time Finished Coring	Time Pulled Off Bottom	Time At Surface	From - To (m)	Notes
1	8/4/10	10.30am	10.50	10.59	11.13	542.5-545.0	Top of formation at 544.88m
2	8/4/10	11.29	12:22	12:30	12:51	545.0-548.05	3.1, 2.7? RQD, Jn=0.5, JR=3.0, JA=1.0
3	8/4/10	15:29	16:50	17:04	17:21	548.05-551.00	2.81 REC, 2.73 RQD, Jn=0.5 JR=3.0, JA=1.0
4	8/4/10	17:38	18:40	18:46	19:10	551.00-554.00	3.09 REC, 3.05 RQD Jn=0.5, JR=3.0, Ja=1.0
5	8/4/10	19.30	20:03	20:10	20:30	554.00-557.00	3.00 REC, 2.44 RQD, Jn=0.5, JR=3.0, Ja=1.0
6	8/4/10	20:45	21:31	21:39	21:53	557.00-560.00	3.04 REC, 2.49 RQD Jn=0.5, JR=3.0, Ja=1.0
7	8/4/10	22:07	23:03	23:11	23:25	560.00-563.00	3.00 REC, 2.92 RQD, Jn=0.5 Jr=3.0 Ja=1.0
8	8/4/10	23:48	0.56	01:05	1:20	563.00-566.00	3.00 REC 3.00 RQD Jn 0.5, Jr 3.0 Ja=1.0
9	9/4/10	01:40	2:53	03:02	3:15	566.0-569.0	3.00 REC 3.0 RQD Jn 0.5 Jr 3.0 Ja=1.0
10	9/4/10	03:35	04:26	04:35	4:45	569.0-572.0	3.00 REC 2.9 RQD Jn 0.5 Jr 3.0 [illegible] 0
11	9/4/10	05:07	05.37	05.49	6:02	572.0-575.0	3.00 REC 3.0 RQD Jn 0.5 Jr 3.0 Ja 1.0
12	9/4/10	06.18	07:07	07:15	7:27	575.0-578.0	3.00 REC 2.75 RQD Jn 0.5 Jr 3.0 Ja 1.0
13	9/4/10	07:42	08:52	09:05	09:13	578.0-581.0	3.00 Rec 3.0 RQD Jn 0.5 Jr 3.0 Ja 1.0
14	9/4/10	9:30	10:43	10:55	11:08	581.0-584.0	3.00 REC, 3.0 RQD, Jn 0.5, Jr 3.0 Ja 1.0
15	9/4/10	11:25	12:11	12:41	12:54	584.0-587.00	3.00 REC, 3.0 RQD, Jn 0.5, Jr 3.0 Ja 1.0
16	9/4/10	13:08	14:00	14:08	14:22	587.0-590.00	3.00 REC, 2.61 RQD, Jn 0.5, Jr 3.0 Ja 1.0
17	9/4/10	14:36	15:48	15:56	16:19	590.00-593.00	3.00 REC, 2.73 RQD, Jn 2.0, Jr 2.0 Ja 1.0
18	9/4/10	16:33	17:35	17:43	18:02	593.00-596.00	3.00 REC, 2.94 RQD Jn 0.5 Jr 3.0 Ja 1.0
19	9/4/10	18:19	19:53	20:03	20:26	596.00-599.00	3.00 REC, 2.63 RQD, Jn 2.0, Jr 2.0 Ja 1.0
20	9/4/10	20:41	22:21	22:28	22:42	599.00-602.00	3.00 REC, 2.93 RQD, Jn 0.5, Jr 3.0, Ja 1.0
21	9/4/10	23:31	00:51	01:04	01:18	602.00-605.00	0.04 REC 0 RQD Jn
22	10/4/10	01.37	01.48	01:54	02:06	602.00 605.15	3.20 rec, 0.5 3.2 Jn 0.5 .15
22	10/4/10	02:19	03:24	03:39	03:48	605.15 608.15	3.05 rec, 3.05, Jn 0.5 Jr 2, Ja .75
23	10/4/10	04:02	04:57	05:07	05:21	608.15 611.15	2.93 rec, 2.80 Jn 4, 1.0, 1.0
24	10/4/10	05:30	06:25	06:36	06:48	611.15-614.15	3.07 rec, 3.07 2.25 Jn 2
25	10/4/10	07:03	08:14	08:26	08:39	614.15-617.15	3.00, 2.25, Jn 2
26	10/4/10	09:08	09:48	09:57	10:13	617.15-620.15	3.00, 3.0, 0.5, 1.0, 0.5

Ensure run timing information is recorded

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Duties and equipment

Sample coal as it is recovered

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Duties and equipment

Measure gas content

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Duties and equipment

Sample gas

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Duties and equipment

Decommission samples

Duties and equipment

Geologist		Date Cored			
Project Owner		Time start coring			
		Time core pulled up			
		Time core at surface			
		Time canister sealed			

Date	Hour	Min.	Volume (mL)	Water Bath Temp. (^{o}C)	Ambient Temp. (^{o}C)	Ambient Pressure (Hg)	Notes

Enter and check data

Duties and equipment

Pack up and shift to new drill site

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Australia Mongolia Extractives Program Phase 2 (AMEP 2) is supported by the Australian Government through the Department of Foreign Affairs and Trade (Australian Aid) and implemented by Adam Smith International.

Tim Moore is currently the **Managing Director of Cipher Consulting Pty Ltd** specializing in advising on coal and coalbed methane exploration. He is also **Adjunct Associated Professor at the School of Earth and Atmospheric Sciences, Queensland University of Technology**, Brisbane, Australia and a **Distinguished Visiting Professor at the School of Resources and Geosciences, China University of Mining and Technology**, Xuzhou, China. Tim is also on the Editorial Boards for the International Journal of Coal Geology and the Indonesian Journal on Geoscience. He has over 260 published papers, reports and abstracts. Over the last 40 years, Tim has worked in production companies, academia and government positions in many parts of the world. (tmoore@ciphercoal.com)

If you want to know more go to the Cipher website & Blog: https://www.ciphercoal.com

Got Questions?

Please visit our website for more information about activities or contact Oyunbileg Purev, Partnership Manager at oyunbileg@amep.mn.

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