

India Discovered Small Fields Executive Summary

August 2016



Worldwide **Petroleum** Consultants


Introduction



- Sproule has been an active player in Asia Pacific throughout the history of the firm with project experience in all major oil and gas countries
- Sproule's office in Brisbane reflects the firm's commitment to servicing clients in the region, leveraging the firm's project experience and expertise in oil and gas advisory, acquisition and divestiture support, reserve certification, and reservoir studies
- The Government of India's Ministry of Petroleum & Natural Gas is offering 46 contract areas in the 2016 discovered small field bid round. Sproule has screened these areas for the largest potential in-place volumes and selected 3 onshore, 4 offshore gas, and 3 offshore oil areas for discussion here.



Selected Project Experience

	India (2001-2010, 2011, 2014)	Fields: Amguri, B192, B45, Changpang, Hazira, W024, PY-1 Blocks: AA-ON/7, Amguri	Categories: Reserves Evaluation Reservoir Study
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India Discovered Small Field Contract Areas

DGH Offering Summary

General

- The DGH is offering 46 contract areas consisting of 67 discovered fields covering 9 sedimentary basins
- All areas have seismic and well test data
- Revenue sharing contract models with India National Oil Companies

Onshore

- 7 different states containing 26 contract areas over 31 fields
- Areas range in size from 2 km² to 28 km²
- OOIP range: 220 Mbbl to 51,000 Mbbl
- OGIP range: 30 MMscf to 102,000 MMscf

Offshore

- 3 different locations containing 20 contract areas over 37 fields
- Areas range in size from 4 km² to 198 km²
- OOIP range: 73 Mbbl to 108,000 Mbbl
- OGIP range: 1,600 MMscf to 228,000 MMscf



★ Location with largest in-place volumes

India Discovered Small Field Contract Areas



DGH Offering Summary

- Most of the onshore discovered small fields are reasonably close to well developed areas. This provides easier access to market & infrastructure
- There is offset field development adjacent to the offshore offerings, but the length and cost of tie-in could be significantly higher
- Assam is the oldest onshore field in India
- The Gujarat state is very business focused & progressive – easy to work with from a commercial sense
 - The current Prime Minister Modi is from this state
- There is more detailed data available for purchase (such as logs, completion reports (WCR), well tests (FER), mapping, seismic etc.)

Data Room Summary



High Level Review (Aug 3, 2016)

- Data was reviewed for 24 fields:
 - 23 fields have available 3D seismic ranging from poor to good quality (depending on year acquired)
 - Mapping is available for each field
 - Well history files and test reports, production data, as well as formation evaluation reports are available for all of the reviewed fields
 - 3D seismic without interpretation and well data (coordinates, logs) is available in Petrel
 - Core (description, extensive biostratigraphy, sparse conventional analysis, etc.) and VSP reports are also available for some of the fields
- For the majority of the fields, the reservoir quality is moderate with low hydrocarbon saturations (~40-60%)
- Fields are underexplored resulting in higher uncertainty in reservoir continuity and quality
- The deterministic in-place hydrocarbon estimates provided by the DGH will likely change with further exploration

Onshore Contract Areas

Assam – Dipling Cluster

- Cluster contains 3 fields (Dipling, Sarojini, and Sapekhati)
- 5 wells drilled, 2 dry. Tested well in each field showed oil
- Combined contract area: 28 km²
- Combined fields' area: ~8.5 km²
- Main payzones: Barail, Tipam
- Combined OOIP (Mbbbl): 51,600
- Combined OGIP (MMscf): 101,700
- All fields covered by 3D seismic of good quality
- 10 to 16 km tie-in



★ Location with largest in-place volumes

Onshore Contract Areas

Assam – Dipling Cluster

- Fault dependent traps covered by 3D seismic of good quality
- Reported net pays are significant, but most of the column is not tested
 - Two zones in Dipling: 14 m & 15 m
 - Two zones in Sarojini : 10 m & 20 m
 - One zone in Sapekhati : 13.5 m
- Porosity: 10-18 %
- Oil saturation: 50-65%
- 1 well is drilled in each of Dipling and Sapekhati (4.1 and 3.4 km² in area); unexplored and volumetric estimates are highly uncertain

Field(s)	Dipling	Sarojini
Location	Assam	
Operator	OIL	
Area, SKM	10.1	8.79
Year of discovery	1985	1990
Main Payzone & Age	Barail, Oligocene Tipam, Mio-Pliocene	Barail, Oligocene Tipam, Mio-Pliocene
Oil Inplace, MBBL	30449	8019
Gas Inplace, MMSCF	28208	1966
3D Seismic, SKM	10	8.8
2D Seismic, LKM	9.1	12.14
Wells drilled	1	3
Wells dry	Nil	2
Nearest Surface facility	Moran OCS of OIL, located 10KM from well Moran-98	Rajgarh Production set-up, located 10Km from well Sarojini-1

Field(s)	Sapekhati
Location	Assam
Operator	OIL
Area, SKM	9.28
Year of discovery	1998
Main Payzone & Age	Barail, Oligocene
Oil Inplace, MBBL	13143
Gas Inplace, MMSCF	71527
3D Seismic, SKM	9.28
2D Seismic, LKM	24.41
Wells drilled	1
Wells dry	Nil
Nearest Surface facility	Rajgarh Production set-up, located 16Km from well Sapekhati-1

Onshore Contract Areas

Assam – Laxmijan Cluster

- Cluster contains 2 fields (Laxmijan and Bihubar)
- 8 wells drilled, 3 dry. One well test in Laxmijan produced oil
- Combined contract area: 9 km²
- Combined fields' max area: ~2.3 km²
- Main payzones: Barail, Tipam
- Combined OOIP (Mbbbl): 25,900
- Combined OGIP (MMscf): 26,500
- All fields covered by 3D seismic of fair quality



 Location with largest in-place volumes

Onshore Contract Areas

Assam – Laxmijan Cluster

- Thrusted and faulted traps
- Fair quality 3D
- Moderate size fields
 - Laxmijan maximum area is 1.5 km²
 - Bilhubar maximum area is 0.8 km²
- Stacked pay zones
 - Four zones in Laxmijan: 5 to 30 m
 - Three zones in Bilhubar: 4.6 to 10.0 m
- Porosity: 10-18%
- Oil saturation: 50-52%
- Complex geology

Field(s)	Llaxmijan	Bihubar
Location	Assam	
Operator	ONGC	
Area, SKM	8.9	
Year of Discovery	1985	
Main Payzone & Age	TS-5A & 5B Miocene	BCS pay of Barail group, Oligocene
Oil Inplace, MBBL	22650	3299
Gas Inplace, MMSCF	22036	4485
3D Seismic, SKM	8.9	
2D Seismic, LKM	18.68	
Wells drilled	3	5
Wells dry	1	2
Nearest City	Nazira town	

Onshore Contract Areas

Assam – Barsila

- Single field located in Upper Assam
- 3 wells drilled, 2 dry. One well test produced gas from the Tipam Sands
- Contract area: 6 km²
- Barsila field area: ~0.8 km²
- Main payzones: Barail, Tipam
- Combined OOIP (Mbbbl): 18,000
- Combined OGIP (MMscf): 23,100
- The field is covered by 3D seismic of poor quality
- ~17km tie-in



 Location with largest in-place volumes

Onshore Contract Areas

Assam – Barsila

- Heavily faulted trap
- Poor to fair quality 3D
- Moderate size pool (0.786 km²)
- Seven stacked pay zones with net pay ranging 8 to 20 m
- Porosity: 14-18%
- Hydrocarbon saturation: 42-50% oil, 53-57% gas
- Complex geology

Field(s)	BARSILA
Location	Upper Assam
Area, SKM	6.22
Operator	ONGC
Year of discovery	1982-83
Main Payzone & Age	Tipam (Miocene) and Barail (Oligocene)
Oil Inplace, MBBL	18032
Gas Inplace, MMSCF	23135
3D Seismic, SKM	3.88
2D Seismic, LKM	Nil
Wells drilled	3
Wells dry	2
Nearest Surface facility	Geleki oil field ~6km
Nearest City	Nazira~ 17km

Offshore Contract Areas - Gas

Gas Contract Areas: B9 Cluster, NMT, B37 Cluster, CA Cluster

- All contract areas are located in Mumbai Offshore
- Main pay zones consist of the Daman, Panvel, Panna, Muhava, Mukta, Bassein, Bombay, Belapur
- All fields have well tests that produced gas

Area	Fields	Contract Area (km ²)	Field Area (km ²)	OGIP (MMscf)	Wells	Dry
B9	3	183	31.3	228,000	6	0
NMT	1	25	12	194,000	3	2
B37	4	124	36.2	157,000	8	3
CA	6	198	12.4	147,000	12	4



★ Location with largest in-place volumes

Offshore Contract Areas - Gas

Gas Contract Areas: B9 Cluster

- Three fields with good quality 3D seismic
- Reservoir net pays:
 - B-9 field has 8 individual pay zones (~1.5 m each)
 - BRC field has a single reservoir zone with average net pay of 1.0 m
 - B-7 field has a single reservoir zone with average net pay of 17.5 m
- Porosity: 10-16%
- Hydrocarbon saturation: 25-58%
- Individual pool areas range from 0.8 to >23 km²:
 - B-9 is the largest field (Daman B-9-3 pool extends over 23 km²)
 - B-7 field area is 7.5 km²
 - BRC field area is 0.8 km²

Field(s)	B-9	B-7	BRC
Location	Mumbai Offshore		
Area, SKM	138.5	22.66	22
Year of Discovery	2005 - 2006	2008 - 2009	2000 - 2001
Main Payzone & Age	Daman pay, Late Formation, Oligocene	Panvel Formation, Late Oligocene	Panna, Palaeocene to lower Eocene
Oil Inplace, MBBL	Nil	Nil	73
Gas Inplace, MMSCF	158492	69570	Nil
3D Seismic, SKM	121.9	22.5	22
2D Seismic, LKM	103.5	45.7	45.4
Wells drilled	3	2	1
Wells dry	Nil	Nil	Nil
Nearest Surface facility	TCPD ~ 85 km	BHN ~ 45-50 KM	BHN ~ 35 km
Nearest City	Mumbai ~220 km		

Offshore Contract Areas - Gas

Gas Contract Areas: NMT Field

- This field is covered by noisy moderate quality 3D seismic
- The trap appears to depend on three faults
- Two reservoir zones with net pay of 9.5 m each
- Porosity: 21%
- Gas saturation: 70%
- Maximum field extent is ~12 km²

Field(s)	BARSILA
Location	Mumbai Offshore
Area, SKM	25.08
Year of Discovery	2003-2004
Main Payzone & Age	Mahuva sand, Lower oligocene
Oil Inplace, MBBL	Nil
Gas Inplace, MMSCF	193892
3D Seismic, SKM	32.1
2D Seismic, LKM	32.5
Wells drilled	3
Wells dry	2
Nearest Surface facility	TCPP ~30 km
Nearest City	Diu

Offshore Contract Areas - Gas

Gas Contract Areas: B37 Cluster

- Four fields covered with poor to fair quality seismic
- Traps are 4-way and 3-way faulted closures
- Reservoir net pays:
 - B-37 = 5 m
 - B-51 = 4.5 m
 - B-174 = 7.2 m
 - B-183 = 2 m
- Porosity: 11-22%
- Hydrocarbon saturation: 35-45%
- Individual pool areas range from 3.1 to 16.4 km²
 - B-37 = 8.1 km²
 - B-51 = 8.5 km²
 - B-174 = 12.5 km²(Bassein), 16.4 km²(Mukta)
 - B-183 = 3.1 km²

Field(s)	B-37	B-51
Location	Mumbai Offshore	
Area, SKM	31	22.3
Year of Discovery	1977 - 1978	1978-1979
Main Payzone & Age	Mukta / Early Oligocene	Mukta Formation, Early Oligocene
Oil Inplace, MBBL	7990	Nil
Gas Inplace, MMSCF	77841	24028
3D Seismic, SKM	31	21.6
2D Seismic, LKM	30.5	16.8
Wells drilled	2	1
Wells dry	1	Nil
Nearest Surface facility	Near Neelam Field	B-173A ~7km

Field(s)	B-174	B-183
Location	Mumbai Offshore	
Area, SKM	46.6	24.3
Year of Discovery	1985 - 1986	1990 - 1991
Main Payzone & Age	Bassein (middle Eocene) & Mukta (Early Oligocene)	Bombay Formation, Middle Miocene
Oil Inplace, MBBL	Nil	Nil
Gas Inplace, MMSCF	52280	2437
3D Seismic, SKM	46.5	12
2D Seismic, LKM	30.7	3.8
Wells drilled	4	1
Wells dry	2	Nil
Nearest Surface facility	B-173A ~10 km	Vasai east & Bassein Field ~15-20 km

Offshore Contract Areas - Gas

Gas Contract Areas: CA Cluster

- Four fields (CA, SD-14, SD-4 and CD) are heavily faulted monoclines with potential stratigraphic lateral seals
- Two fields (ED-4 & TP) are structural traps
- 3D seismic available for CD, ED-4, SD-14 and TP fields
- Reservoir net pays:
 - CA = 1.3 – 14.8 m (Mahuva)
 - SD-14 = 1.0 – 2.6 m (Daman)
 - SD-4 = 3.8 m (Daman)
 - TP = 3.0 m (Daman), 2.0 m (Mahuva)
 - CD = 2.3 m (Daman), 6.1 m (Mahuva)
 - ED-4 = 3.0 m (Belapur)
- Porosity: 14-28%
- Hydrocarbon saturation: 43-63% oil, 34-70% gas
- Individual pool areas range from 0.8 to 3.1 km²
 - CA = 3.1 km² (Mahuva)
 - SD-14 = 2.0 km² (Daman)
 - SD-4 = 3.1 km² (Daman)
 - TP = 2.7 km² (Daman), 2.7 km² (Mahuva)
 - CD = 0.8 km² (Daman), 0.3 km² (Mahuva)
 - ED-4 = 0.8 km² (Belapur)

Field(s)	CA	SD-14	SD-4
Location	Mumbai Offshore		
Area, SKM	81.42		43.8
Year of Discovery	1986-1987	1989-1990	1988-1989
Main Payzone & Age	Mahuva, early Oligocene	Daman, lade Oligocene	Daman, late Oligocene
Oil Inplace, MBBL	14147	Nil	1100
Gas Inplace, MMSCF	124138	2553	6554
3D Seismic, SKM	47.5		Nil
2D Seismic, LKM	103.8		43.6
Wells drilled	4	2	2
Wells dry	1	1	1
Nearest Surface facility	TCPP ~20 km	C-24 MOPU: ~30 km	C-24 MOPU: ~35 km

Field(s)	TP	CD	ED-4
Location	Mumbai Offshore		
Area, SKM	25.1	19.3	28.6
Year of Discovery	1990 -2000	1986-1987	2000 - 2001
Main Payzone & Age	Daman and Mahuva Oligocene	Daman and Mahuva Oligocene	Belapur, Eocene age
Oil Inplace, MBBL	Nil	367	220
Gas Inplace, MMSCF	11654	1614	Nil
3D Seismic, SKM	25	18.1	28.6
2D Seismic, LKM	41	23.9	37.9
Wells drilled	1	2	1
Wells dry	Nil	1	Nil
Nearest Surface facility	C-24 MOPU: ~20 km	C-24 MOPU: ~30 km	C-24 MOPU: ~40 km

Offshore Contract Areas - Oil

Oil Contract Areas: D18, D31 Cluster, KD

- Contract areas located in Mumbai Offshore and Kutch Offshore
- Main payzones consist of the L-VI, Mukta, Bandra, Bassein
- All fields had well tests that produced oil with gas and sometimes trace condensate

Area	Fields	Contract Area (km ²)	Field Area (km ²)	OOIP (Mbbbl)	Wells	Dry
D18	1	97	3.8 to 46.1	108,000	8	1
D31	2	105	10.3 to 21.8	28,000	3	0
KD	1	46	9.7	19,000	2	1



★ Location with largest in-place volumes

Offshore Contract Areas - Oil

Oil Contract Areas: D18

- Consists of one field
- Good quality 3D seismic
- Faulted 4 way closure with seven stacked sands
- Elevated H₂S content in some zones
- Wet wells at the same elevation as crestal productive wells
- Large area (3.8 to 46.1 km² depending on pay zone)
- Net pay, porosity, and saturation were not presented

Field(s)	BARSILA
Location	Mumbai Offshore
Area, SKM	97.42
Year of Discovery	1985-1986
Main Payzone & Age	L-VI & Mukta, Oligocene
Oil Inplace, MBBL	108337
Gas Inplace, MMSCF	72808
3D Seismic, SKM	97.4
2D Seismic, LKM	242.4
Wells drilled	8
Wells dry	1
Nearest Surface facility	D1FPSO ~ 25 km
Nearest City	Mumbai

Offshore Contract Areas - Oil

Oil Contract Areas: D31 Cluster

- Two fields covered with poor to fair quality 3D seismic
- Traps are fault dependent
- Large areal extent (10.3 km² for D-31 and 21.8 km² for D-12)
- Reservoir quality
 - D-31: 11.3 m of net pay with 12.4% porosity and 42% hydrocarbon saturation
 - D-12: 3.4 m of net pay with 18.1% porosity and 30% hydrocarbon saturation

Field(s)	D-31	D-12
Location	Mumbai Offshore	
Area, SKM	53	51.97
Year of Discovery	2000 - 2001	1981 - 1982
Main Payzone & Age	L-II (Bandra), early to Middle Miocene	Basseain, Middle Eocene
Oil Inplace, MBBL	27707	Nil
Gas Inplace, MMSCF	18915	21817
3D Seismic, SKM	52.6	51.8
2D Seismic, LKM	89.85	105.4
Wells drilled	2	1
Wells dry	Nil	Nil
Nearest Surface facil	B-192 platforms ~ 15 km	B-192 platforms ~ 20 km
Nearest City	Mumbai ~ 215km	

Offshore Contract Areas - Oil

Oil Contract Areas: KD

- Consists of one field
- Broad anticline (9.7 km²) covered with poor to fair quality 3D seismic
- One pay zone with moderate reservoir quality
 - Net pay: 4.9 m
 - Porosity: 19.4%
 - Hydrocarbon saturation: 34.1 %

Field(s)	KD
Location	Kutch Offshore
Area, SKM	46
Year of Discovery	1984-1985
Main Payzone & Age	Limestone/Sandstones of Early Eocene
Oil Inplace, MBBL	19131
Gas Inplace, MMSCF	1939
3D Seismic, SKM	43
2D Seismic, LKM	63.9
Wells drilled	2
Wells dry	1
Nearest Surface facility	Nearest land point is about 75 km
Nearest City	Koteshwar

Sroule's Strategic Advisory

Delivering objective opinions and solutions



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Our independence, strong commercial understanding, commitment to the highest standards of integrity and focus on client success means we are routinely sought out as trusted advisors for M&A related due diligence.

Acting for IOCs, NOCs, independents, financial institutions and other stakeholders, Sroule has an established track record of advising clients on mergers and acquisitions, technical due diligence and fair market valuations. Our independent reports are used in the sell-side marketing processes, and we are often retained as a technical advisor for quantitative and qualitative analysis of target assets.


We've established ourselves as the go-to advisor for unconventional projects by advising on several landmark transactions of the past decade. Additionally, we are uniquely positioned to assist companies with their review of integrated LNG projects having advised on many mandates related to North America's burgeoning LNG industry.

Sroule also provides asset management services to creditors and receiver-trustees in order to protect enterprise values, as well as to assess and identify value maximization opportunities.

Strategic Advisory Services

- Mergers and Acquisition Advisory
- Private Equity
- Technical Due Diligence
- Asset Management
- Asset Portfolio Optimization
- Abandonment & Reclamation
- LNG Advisory
- Fair Market Valuations
- Unitization

Selected Strategic Advisory Projects

Integrated LNG due diligence	Fair market valuation	Technical due diligence of gas storage assets	Technical due diligence	Due diligence, CPR & valuation report
Major utilities company	Major investment fund	Major pension fund	Major investment bank	
Canada 2015	DR Congo 2015	Australia 2015	Colombia 2014	China 2014



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