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APPENDIX D

ROV Survey Reports



Eni JPDA 06-105

KITAN-1 EXPLORATION DRILLING: ROV ENVIRONMENTAL SURVEY REPORT

JPDA06105-K1-HSE-RP-001

APRIL 2008

Eni JPDA 06-105 Pty Ltd
Level 3, 40 Kings Park Road,
West Perth WA 6005

Tel: +61 8 9320 1111 ♦ Fax: +61 8 9320 1100
email: info@eniaustralia.com.au



Document Number:					
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Originating Department:		HSE			
Author/s:		John Nielsen (Sustainability Pty Ltd)			
Custodian:		Tony Heynen			
Document Title					
<h2 style="margin: 0;">Kitan-1 Exploration Drilling ROV Environmental Survey Report</h2>					
Abstract:					
<p>This report describes the findings of the Kitan-1 exploration well post-drilling ROV environmental survey. It documents observed impacts on the seabed and associated biota from drilling cuttings generated during the Kitan-1 drilling campaign. The report was prepared for submission to the Timor Sea Designated Authority (TSDA) as the designated authority for the Joint Petroleum Development Area (JPDA), as required under Eni JPDA06-105 Pty Ltd's (Eni) environmental approval to drill the Kitan-1 well.</p>					
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ABBREVIATIONS

Eni	Eni JPDA 06-105 Pty Ltd
EMP	Environmental Management Plan
JPDA	Joint Petroleum Development Area
MODU	Mobile Offshore Drilling Unit
NNE	North northeast
NNW	North northwest
PGB	Permanent Guide Base
ROV	Remotely Operated Vehicle
SSE	South southeast
TSDA	Timor Sea Designated Authority



1. INTRODUCTION

Eni JPDA 06-105 Pty Ltd (Eni) carried out exploration drilling of the Kitan-1 well, located in Permit Area JPDA 06-105, during January 2008. Permit Area JPDA 06-105 is located in the Joint Petroleum Development Area (JPDA) and administered by the Timor Sea Designated Authority (TSDA) on behalf of the governments of Timor-Leste and Australia. The environmental impacts of the Kitan-1 drilling program were managed under the Kitan-1 Environmental Management Plan (EMP) (Eni 2008), which was submitted to the TSDA in December 2007.

The Kitan-1 well, situated in a water depth of approximately 312m, was drilled by the mobile offshore drilling unit (MODU) Songa Venus. During the Kitan-1 campaign, the top 2127m of the well were drilled riserless i.e. with cuttings discharged directly onto the seabed adjacent to the well. The bottom 1400m were drilled using a riser i.e. cuttings were brought up to the MODU, separated from drilling muds using shale shakers and then discharged at the sea surface. The top and bottom well sections generated approximately 330m³ and 78m³ of drilling cuttings respectively.

Due to the proximity of Kitan-1 to the Big Bank Shoals (Heyward *et. al.* 1997), situated 3km to the southwest, Eni carried out dispersion modelling of drill cuttings in order to predict the spatial extent of their dispersion and settlement on the seabed (Sustainability 2007). Dispersion modelling was carried out for the 78m³ cuttings from the bottom section because these were released at the sea surface and therefore had the greatest potential to disperse over a wide area as they sink through the water column. The majority of these cuttings (98%) were predicted to settle within 300m of the well head and have no detectable impact on the Big Bank Shoals (Sustainability 2007).

Dispersion modelling was not carried out for the 330m³ of cuttings from the riserless top section as these were deposited directly on the seabed and thus predicted to form localised mounds within metres of the well head that would erode over time by bottom currents (Sustainability 2007). In its EMP, Eni committed to conducting a remotely operated vehicle (ROV) survey of the seabed around the Kitan-1 well head to determine whether the deposition of drilling cuttings and associated impacts on benthic fauna were as predicted. This document reports on the findings of Eni's post-drilling ROV survey of the Kitan-1 well.



2. METHODS

An ROV survey of the seabed surrounding the Kitan-1 well was conducted on 8 January 2008, prior to drilling, and again on 1 March 2008, within days of well completion, using a Sealion ROV unit. During the surveys, seabed topography was mapped using the ROV's SIMRAD sonar unit to determine the presence and location of cuttings mounds. Sonar scans were taken on cardinal bearings (north, south, east and west) at ranges of 10m, 25m, 50m and 100m from the well head on each bearing. The ROV's video camera was then used to film the seabed along a 50m transect, emanating from the well head, on each cardinal bearing. Data from the sonar survey and images from the video transects were then used to determine the presence of drill cuttings mounds and the effect of cuttings on water turbidity and benthic organisms.

3. RESULTS

3.1 CUTTINGS MOUNDS

Prior to drilling, the seabed surrounding the Kitan-1 well appeared to be a flat, featureless plain with no evidence of mounds or depressions. The seabed was generally comprised of fine sand and mud sediments although a sonar scan suggested small areas of cobble occurred to the north. Water depth generally ranged between 311m and 313m.

Water depth at the well head, as measured by the ROV's depth gauge, ranged between approximately 309m and 310.7m, compared with the general water depth of between 311m and 313m measured at 50m from the well head. This differential in water depth suggested that a cuttings mound of approximately two metres in height surrounded the well head. This was corroborated by the ROV Operator who commented during the survey that the pre-drilling (natural) seabed surface was approximately two metres below the bottom of the permanent guide base (PGB) (Figure 3.1), whereas was level with the PGB after drilling (Figure 3.2). The ROV Operator also reported that, earlier, the post-drilling sediments had been almost level with the top of the PGB guideposts, suggesting that a substantial quantity of cuttings had been quickly eroded and washed away.

Sonar scans detected cuttings mounds to the northwest, southeast and northeast of the well head. On the west cardinal bearing, a cuttings mound of approximately 2m x 5m in area was detected at approximately 2m to the northwest of the well head (Figure 3.3). Scans at a range of 25m, 50m and 100m on this cardinal bearing confirmed that this was the only feature of note with no other cuttings mounds detected on this bearing.

On the north cardinal bearing, a cuttings mound of approximately 5m x 5m was detected at 2m from the well head (Figure 3.4). This was the only feature of note on this cardinal bearing. On the east cardinal bearing, a cuttings mound of approximately 2m x 4m was detected at about 2m to the southeast of the well head (Figure 3.5). No cuttings mounds were detected on the south cardinal bearing.

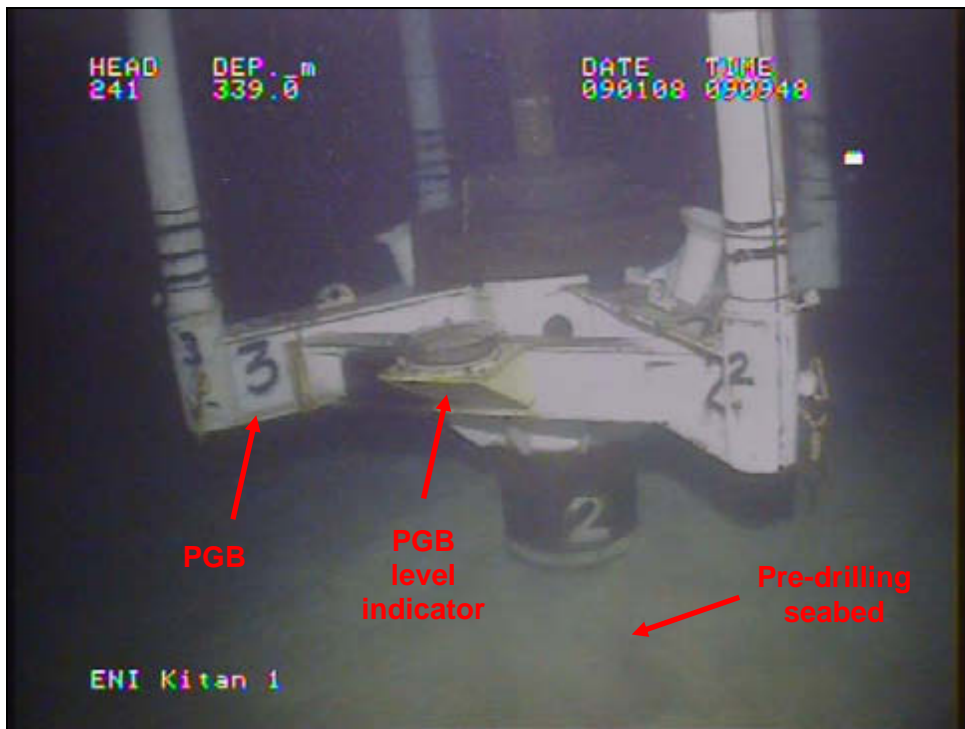


Figure 3.1: View of PGB prior to drilling, showing the base of the PGB approximately 2m above the pre-drilling (natural) sediment surface



Figure 3.2: View of PGB (upper background) showing sediments at or slightly covering its base

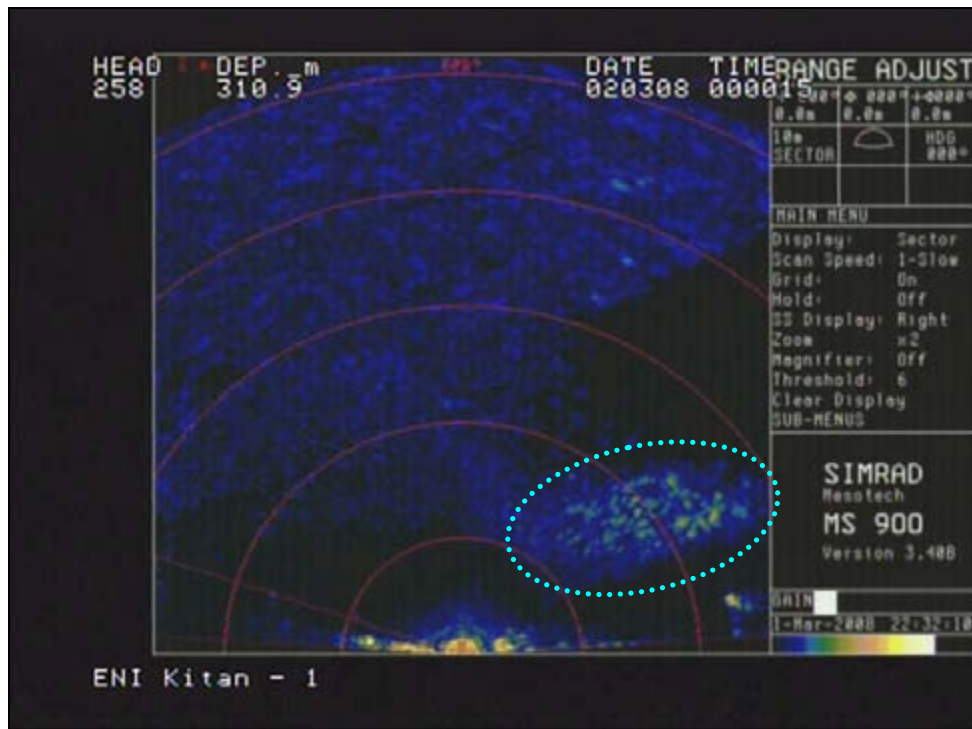


Figure 3.3: Sonar scan on west cardinal bearing at 10m range (range rings are at 2m intervals). A cuttings mound to the northwest of the well head is indicated by the blue ellipse

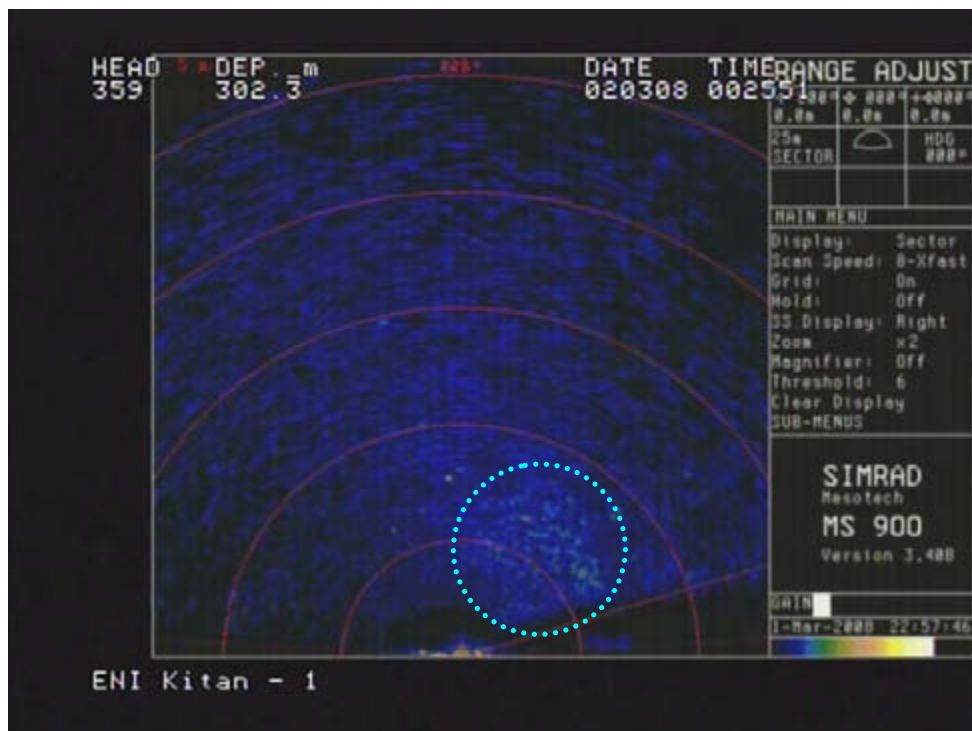


Figure 3.4: Sonar scan on north cardinal bearing at 25m range (range rings are at 5m intervals). A cuttings mound to the northeast of the well head is indicated by the blue circle

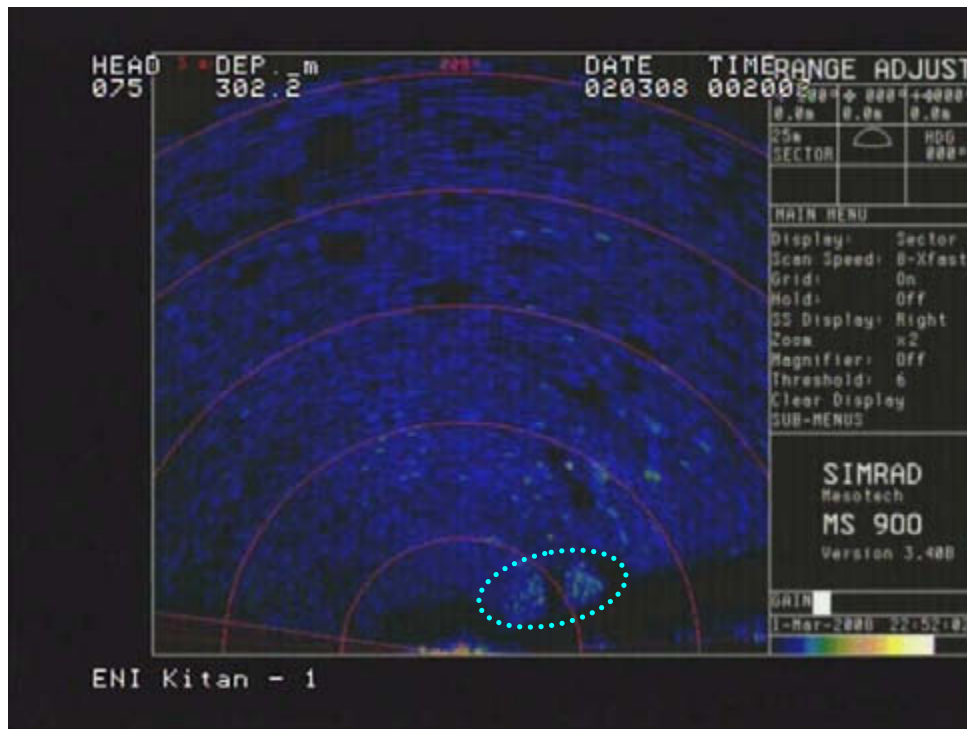


Figure 3.5: Sonar scan on east cardinal bearing at 25m range (range rings are at 5m intervals). A cuttings mound to the northeast of the well head is indicated by the blue ellipse

3.2 WATER TURBIDITY AND BENTHIC FAUNA

During the ROV survey, the well head and the seabed were clearly visible from several metres away (Figure 3.6). Thus, water turbidity was interpreted to be low (i.e. a high water clarity) especially because water depth was over 300m and the ROV was the only source of illumination. Crustaceans were abundant in the water column above the well head and were observed swimming across the field of view (Figure 3.7) possibly attracted by the ROV lights.

On each of the four 50m video transects, the seabed was observed to be a flat, featureless plain comprised of fine sediments. Infauna (animals inhabiting the seabed) were observed to be abundant as evidenced by burrows. Epibenthic fauna (living on or near the sediment surface) such as hermit crabs and fish were also common (Figure 3.8). Water turbidity was observed to be low, with the seabed generally clearly visible from several metres away throughout the length of each transect (with the exception of those occasions when the ROV unintentionally made contact with the seabed during the survey resulting in disturbance of the surface sediments).

The ROV video confirmed the presence a cuttings mound located at approximately 2m from the wellhead and extending out for a further 5m (Figure 3.9). The water depth over this mound rose to approximately 303m at its shallowest point, suggesting a height of 8-10m above the surrounding seabed surface. The rippled seabed beyond the mound, such as that observed at approximately 13m from the well head (Figure 3.10), confirmed that the mound was relatively small. Hermit crabs and fish were observed at this location (Figure 3.10) suggesting that any impacts of drilling cuttings on infauna and epibenthos, such as smothering, were localised.



Figure 3.6: Well head clearly visible from several metres away



Figure 3.7: Typical view of crustaceans (marked with an arrow) swimming across the ROV's field-of-view above the well head



Figure 3.8: Typical view of seabed surrounding Kitan-1 showing current-induced ripples, infauna burrows and epibenthic crabs and fish



Figure 3.9: Cuttings mound located to the north of the Kitan-1 well head



Figure 3.10: Rippled seabed and hermit crabs observed at approximately 14m north of the Kitan-1 well head, immediately north of a cuttings mound



4. DISCUSSION

Modelling of the 78m³ of drilling cuttings released at the sea surface i.e. from drilling with a riser, indicated that the majority of cuttings would settle on the seabed within 300m of the well with a resulting average concentration of 5kgm⁻² – 10kgm⁻² and average thickness of 4mm (Sustainability 2007). This level of impact would be so low as to be undetectable in the ROV survey. Indeed, the ROV showed that, with the exception of some localised cuttings mounds occurring within 10m of the well head, the seabed appeared rippled from natural water movement and inhabited by a variety of infauna and epibenthic fauna typical of an undisturbed (natural) seabed.

Sustainability (2007) did not model the dispersal of the 330m³ of cuttings from riserless drilling (i.e. those cuttings released directly to the seabed adjacent to the well) as it was considered likely to cause only localised smothering of the seabed and associated benthic organisms. The findings of the ROV survey supported this assertion as mounds were detected within 10m of the well head to the northwest, north, northeast and southeast and appeared small, generally covering an area of less than 5m x 5m. Beyond 10m of the wellhead, the seabed appeared rippled and inhabited by infauna such as polychaete worms. Epibenthic fauna such as hermit crabs and fish were also common in close proximity to the well head and associated cuttings mounds, further supporting the view that the impacts of the cuttings discharge were localised.

The locations of observed cuttings mounds appear to correspond with the prevailing tidal current regime. Sustainability (2007) reported that tidal currents are anti-clockwise rotational, flooding towards the south-southeast (SSE) and ebbing towards the north-northwest (NNW). Thus, over a tidal cycle, a net water movement towards the north-northeast (NNE) is superimposed on the SSE-NNW current axis. This may explain the observed distribution of cuttings mounds to the northwest, north, northeast and southeast, and lack of observed mounds to the south and southwest. Thus, it would appear that the general distribution of cuttings from the riserless section was away from the Big Bank Shoals.

Sustainability (2007) estimated that the cutting mound produced by riser-less drilling would be in the order of 1m in height. However, the ROV survey indicated that a mound of approximately 2m in height occurred immediately around the well head and a mound of possibly 8m – 10m in height occurred to the north. Despite this difference between expected and observed mound heights, it is likely that the finer cuttings particles would be resuspended and redistributed within a short period of time. This is supported by the ROV Operator's observation that cuttings which had once almost covered the PGB guideposts during drilling had been transported away by water currents near the seabed by the end of drilling. Thus, in time, the cuttings are likely to be eroded and merged with the background sediments.

The findings of the ROV survey support the view that impacts on benthic organisms from drilling the Kitan-1 well such as smothering would be localised. The results also support the prediction that drilling the Kitan-1 well would not result in the smothering of fauna inhabiting the Big Bank Shoals located 3km to the southwest.



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- Heyward, A., Pinceratto, E. and Smith, L. 1997. *Big Bank Shoals of the Timor Sea: An Environmental Resource Atlas*. Australian Institute of Marine Science, Townsville, Queensland.
- Sustainability. 2007. *Kitan-1 Drill Cutting Dispersion Modelling*. Unpublished report prepared by Sustainability Pty Ltd for Eni JPDA06-105 Pty Ltd, Perth, Western Australia.



Eni JPDA 06-105

KITAN-2 EXPLORATION DRILLING ROV ENVIRONMENTAL SURVEY

JPDA06105-K2-HSE-RP-001

APRIL 2008

Eni JPDA 06-105 Pty Ltd
Level 3, 40 Kings Park Road,
West Perth WA 6005
Australia

Tel: +61 8 9320 1111 ♦ Fax: +61 8 9320 1100
email: info@eniaustralia.com.au



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Originating Department:		HSE			
Author/s:		John Nielsen (Sustainability Pty Ltd)			
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Figure 3.7: Sonar scan on south cardinal bearing at 100m range. A cuttings mound is indicated by the blue ellipse 8

Figure 3.8: Sonar scan on west cardinal bearing at 100m range. A cuttings mound is indicated by the blue circle 8



ABBREVIATIONS

Eni	Eni JPDA 06-105 Pty Ltd
EMP	Environmental Management Plan
HSE	Health Safety & Environment
JPDA	Joint Petroleum Development Area
MODU	Mobile Offshore Drilling Unit
PGB	Permanent Guide Base
ROV	Remotely Operated Vehicle
TSDA	Timor Sea Designated Authority



1. INTRODUCTION

Eni JPDA 06-105 Pty Ltd (Eni) carried out exploration drilling of the Kitan-2 well, located in Permit Area JPDA 06-105, during March 2008. Permit Area JPDA 06-105 is located in the Joint Petroleum Development Area (JPDA) and administered by the Timor Sea Designated Authority (TSDA) on behalf of the governments of Timor-Leste and Australia. The Kitan-2 well was located 1.6km west of the Kitan-1 well, drilled in January 2008. The environmental impacts of the Kitan-2 drilling program were managed under the Kitan-2 Environmental Management Plan (EMP) (Eni 2008a), which was submitted to the TSDA in January 2008.

The Kitan-2 well, situated in a water depth of approximately 328m, was drilled by the mobile offshore drilling unit (MODU) *Songa Venus*. During the Kitan-2 campaign, the top 2500m of the well were drilled riserless i.e. with cuttings discharged directly onto the seabed adjacent to the well. The bottom 1025m were drilled using a riser i.e. cuttings were brought up to the MODU, separated from drilling muds using shale shakers and then discharged at the sea surface. The top and bottom well sections generated approximately 398m³ and 86m³ of drilling cuttings respectively.

Due to the proximity of Kitan-2 to the Big Bank Shoals (Heyward *et. al.* 1997), situated approximately 4.5km to the southwest, Eni carried out dispersion modelling of drill cuttings in order to predict the spatial extent of their dispersion and settlement on the seabed (Sustainability 2008). Dispersion modelling was carried out for the 86m³ cuttings from the bottom section of the well because these were released at the sea surface and therefore had the greatest potential to disperse over a wide area as they sink through the water column. The majority of these cuttings (98%) were predicted to settle within 300m of the well head and to have no detectable impact on the Big Bank Shoals (Sustainability 2008).

Dispersion modelling was not carried out for the 398m³ of cuttings from the riserless top section of the well as these were deposited directly on the seabed and thus predicted to form localised mounds within metres of the well head that would erode over time by bottom currents (Sustainability 2008). In its EMP, Eni committed to conducting a remotely operated vehicle (ROV) survey of the seabed around the Kitan-2 well head to determine whether the deposition of drilling cuttings and associated impacts on benthic fauna were as predicted. This document reports on the findings of Eni's post-drilling ROV survey of the Kitan-2 well.



2. METHODS

An ROV survey of the seabed surrounding the Kitan-2 well was conducted on the 3rd March, prior to drilling, and again on 28th March 2008, within days of well completion, using a Sealion ROV unit. During the surveys, seabed topography was mapped using the ROV's SIMRAD sonar unit to determine the presence and location of cuttings mounds. Sonar scans were taken on cardinal bearings (north, south, east and west) at ranges of 10m, 25m, 50m and 100m from the well head on each bearing. The ROV's video camera was then used to film the seabed along a 50m transect, emanating from the well head, on each cardinal bearing. Data from the sonar survey and images from the video transects were then used to determine the presence of drill cuttings mounds and the effect of cuttings on water turbidity and benthic organisms.

3. RESULTS

Prior to drilling, ROV sonar scans and visual surveys showed the seabed surrounding the Kitan-2 well to be a flat, featureless plain with no evidence of mounds or depressions (Figures 3.1 and 3.2). The seabed was generally comprised of fine sand and mud sediments with patches of shell sand material and cobble rubble (Figure 3.3). Water depth was approximately 328m.

Post-drilling, there was a 2m high cuttings mound immediately surrounding the wellhead. Prior to drilling, the seabed surface was 2m below the permanent guide base (PGB) whereas after drilling, the seabed surface was level with the base of the PGB (Figure 3.4). Sonar scans to the north, east, south and west detecting cuttings mounds in all directions to up to 30m from the wellhead (Figures 3.5 – 3.8). The surface area of the cuttings mounds ranged from 180 square metres up to 390 square metres (Figures 3.5 – 3.8). The cuttings appeared to be approximately 2m in height (as observed immediately around the PGB) except for one mound to the west where the mound appeared to be up to 10m in height, based on observed variations in water depth measured using the ROV's depth gauge.

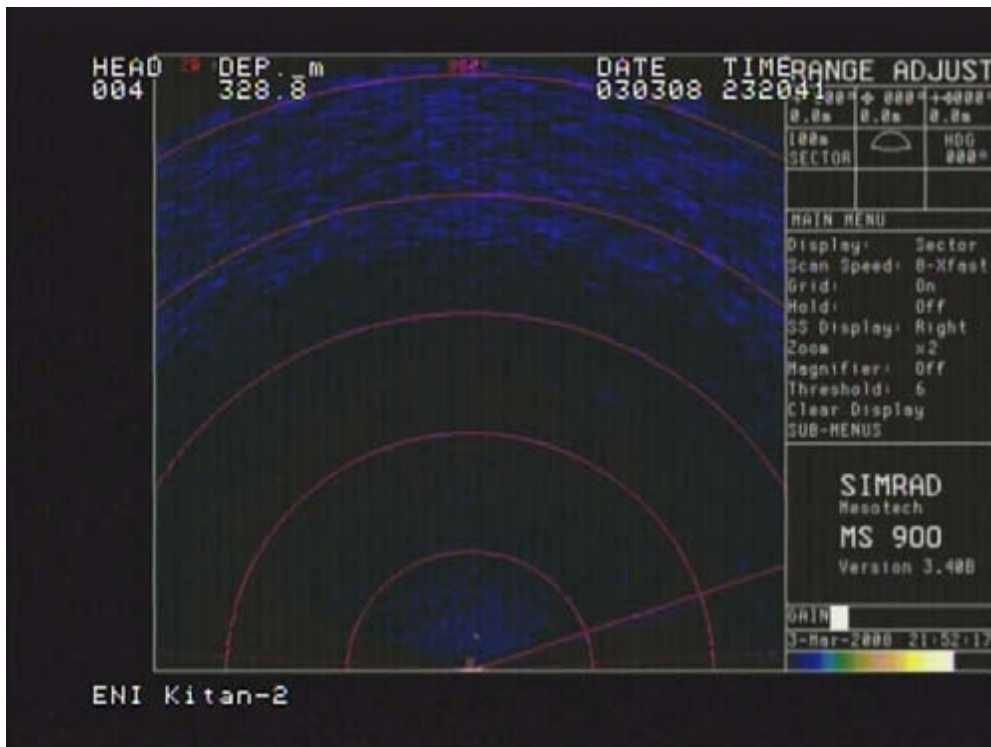


Figure 3.1: Pre-drilling sonar scan on north cardinal bearing at 100m range (range rings are at 20m intervals) showing no evidence of seabed elevations



Figure 3.2: Typical view of seabed at Kitan-2 prior to drilling. A starfish and fish are visible



Figure 3.3: View of seabed north of Kitan-2 prior to drilling showing cobbles (probably coral rubble) scattered across the otherwise muddy seabed



Figure 3.4: Cuttings mound level with the base of PGB (seabed was 2m below PGB prior to drilling)

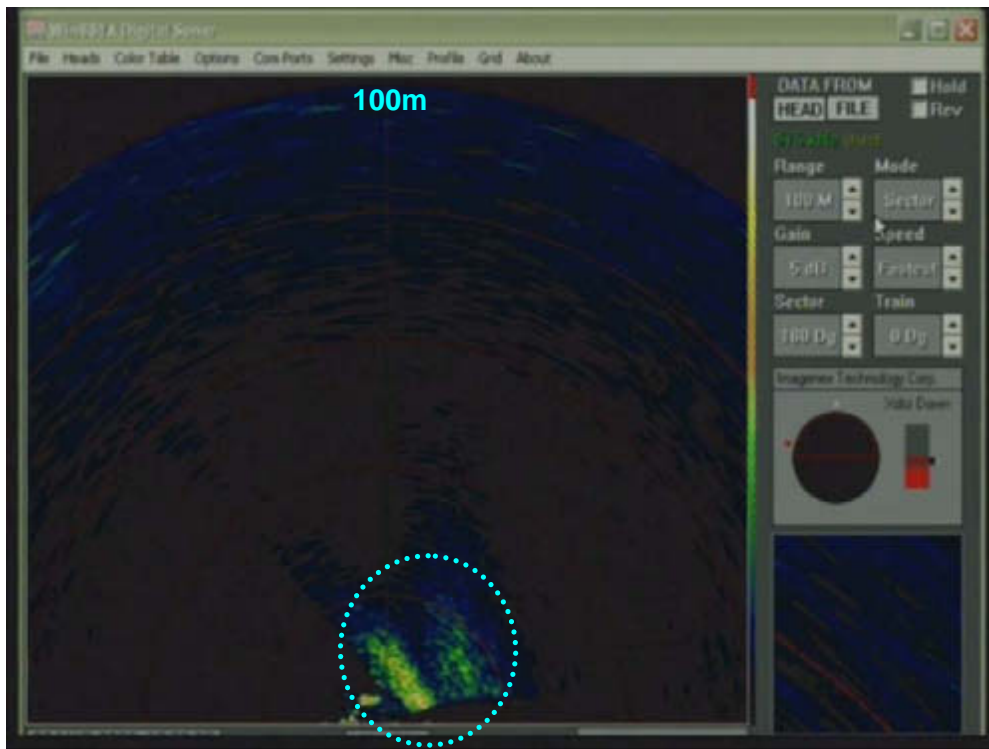


Figure 3.5: Sonar scan on north cardinal bearing at 100m range. A cuttings mound is indicated by the blue circle

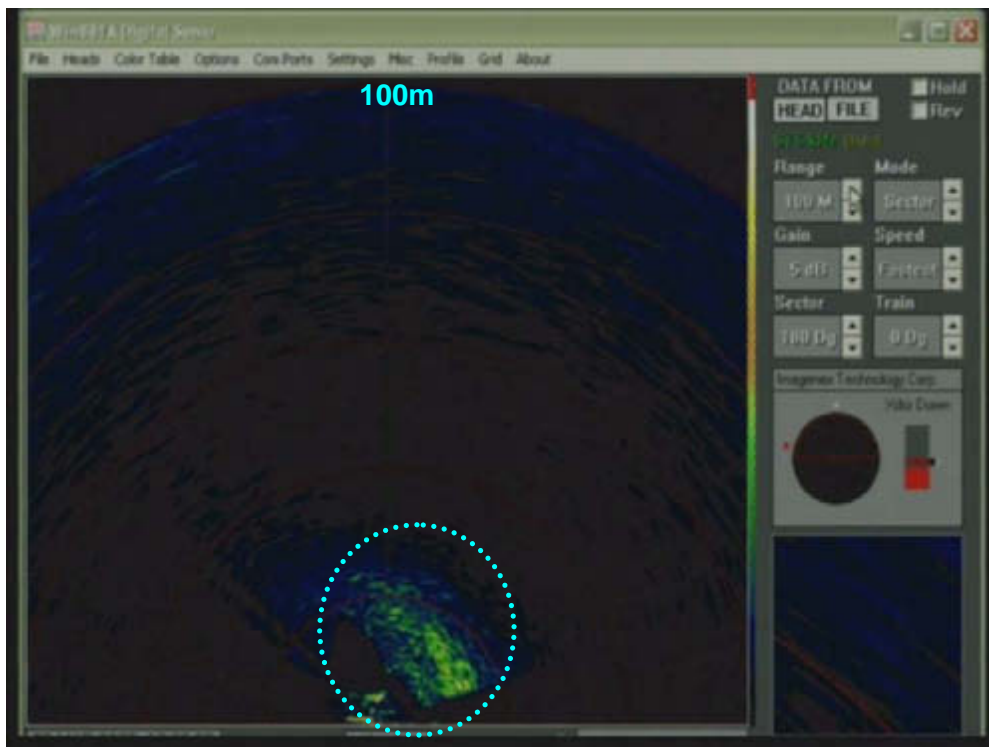


Figure 3.6: Sonar scan on east cardinal bearing at 100m range. A cuttings mound is indicated by the blue circle

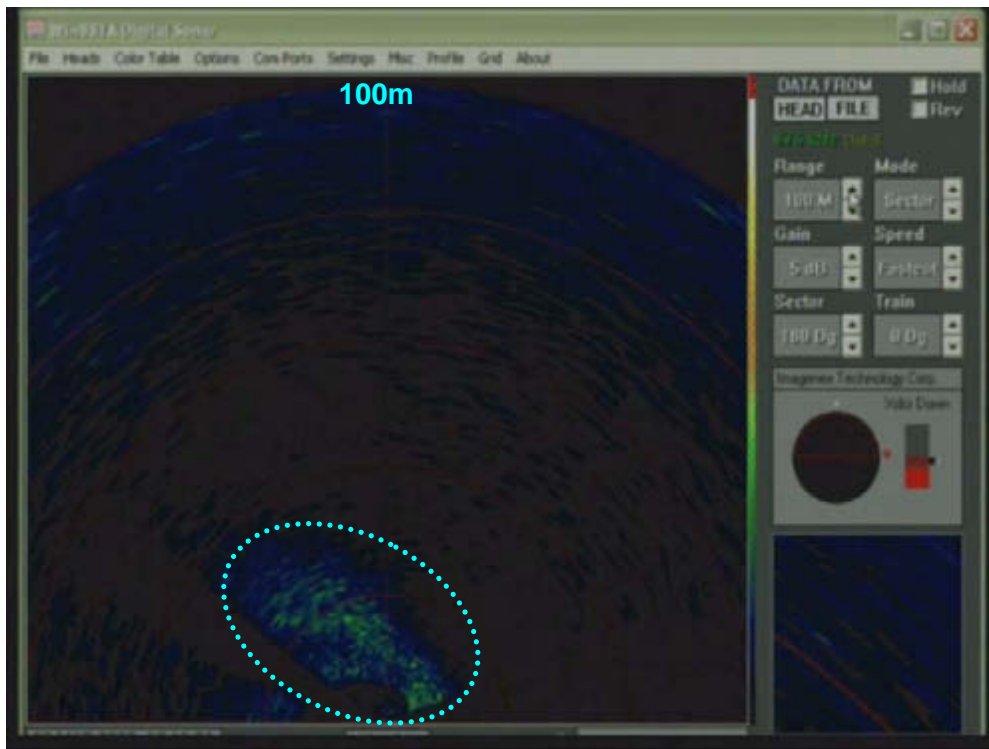


Figure 3.7: Sonar scan on south cardinal bearing at 100m range. A cuttings mound is indicated by the blue ellipse

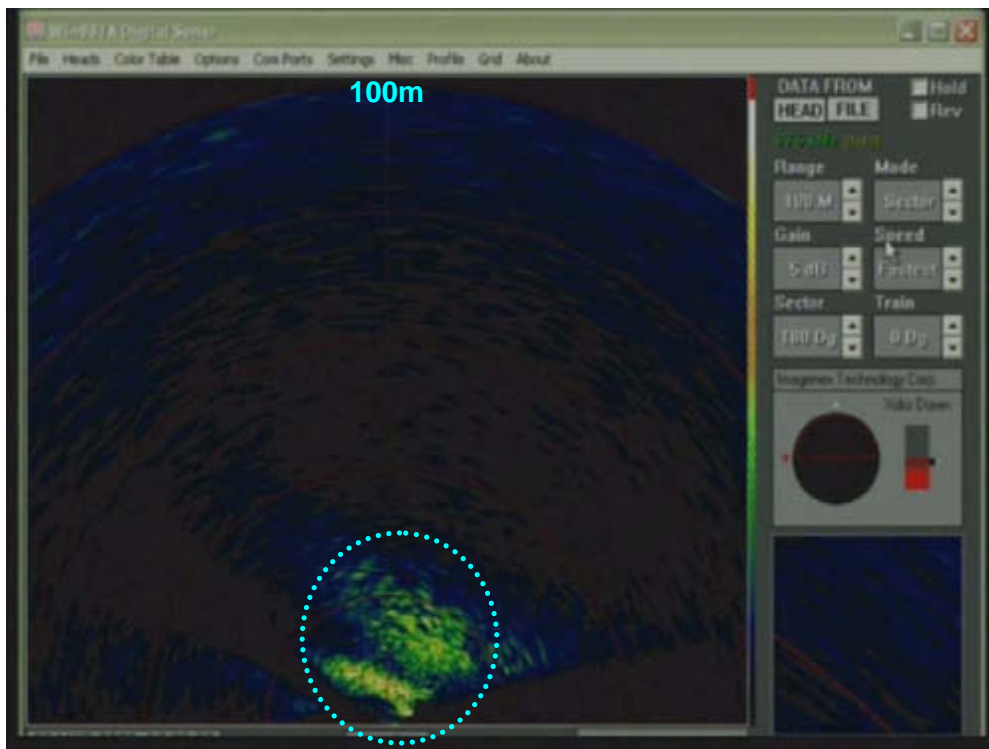


Figure 3.8: Sonar scan on west cardinal bearing at 100m range. A cuttings mound is indicated by the blue circle



4. DISCUSSION

Modelling of the 86m³ of drilling cuttings released at the sea surface i.e. from drilling with a riser, indicated that the majority of cuttings would settle on the seabed within 300m of the well with a resulting average concentration of 5kgm⁻² – 10kgm⁻² and average thickness of 4mm (Sustainability 2008). This level of impact would be so low as to be undetectable in the ROV survey.

Sustainability (2008) did not model the dispersal of the 398m³ of cuttings from riserless drilling (i.e. those cuttings released directly to the seabed adjacent to the well) as it was considered likely to cause only localised smothering of the seabed and associated benthic organisms. The Kitan-2 mounds were larger and more widespread than those observed after the Kitan-1 drilling campaign (Eni 2008b). The Kitan-2 mounds ranged in area from approximately 180 square metres (to the south) to up to 390 square metres (to the west) in contrast to the largest Kitan-1 mound of 25 square metres (Eni 2008b). The Kitan-2 mounds were observed at a distance of up to 30m from the wellhead, compared to 10m for Kitan-1.

Sustainability (2008) estimated that the cutting mound produced by riser-less drilling would be in the order of 1m in height. However, the ROV survey indicated that a mound of approximately 2m in height occurred immediately around the well head and a mound of possibly 10m in height occurred to the west. Despite this difference between expected and observed mound heights, it is likely that the finer cuttings particles would be resuspended and redistributed within a short period of time. During the Kitan-1 post-drill survey, the ROV Operator observed that cuttings which had once almost covered the PGB guideposts during drilling had been transported away by water currents near the seabed by the end of drilling (Eni 2008b). Thus, in time, the cuttings are likely to be eroded and merged with the background sediments.

Despite the larger cutting mounds observed at Kitan-2, the ROV survey nevertheless supports the conclusion that smothering of the seabed was localised. The results also support the prediction that drilling the Kitan-2 well would not result in the smothering of fauna inhabiting the Big Bank Shoals located 4.5km to the southwest.



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