

Problems of Oil Spill Response



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Composition of crude oils

- Crude oils are mixtures of many thousands of different hydrocarbons
- These range from propane to bitumen
- Different crude oils have different proportions and therefore different properties



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Relevant oil properties

CRUDE OIL ASSAY OR DATA SHEETS

- Density, Specific Gravity, API Gravity
- Volatility - related to boiling point
- Viscosity
- Pour point
- Wax content
- Asphaltene content



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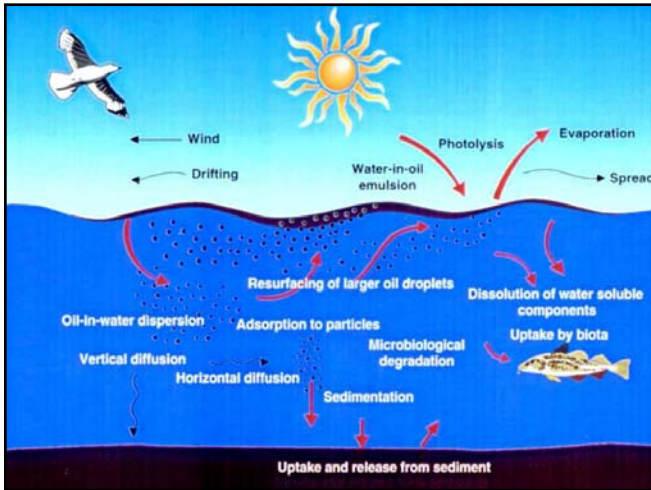


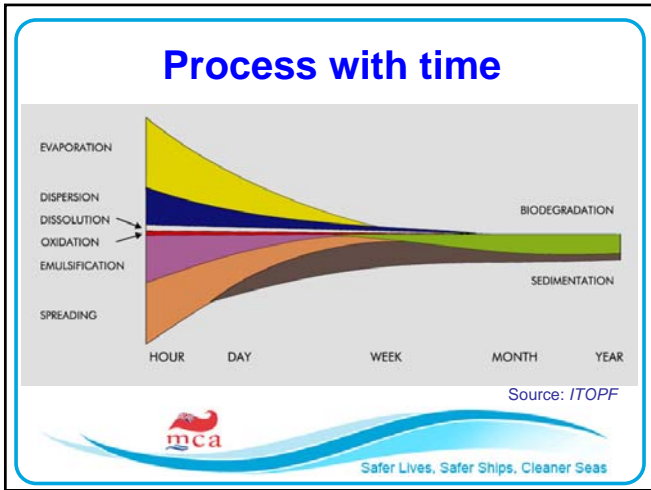


Fate of spilled oil

- Major processes
 - Spreading
 - Evaporation
 - Emulsion formation
 - Natural dispersion
- Other processes
 - Dissolution
 - Oxidation
 - Sedimentation
 - Biodegradation


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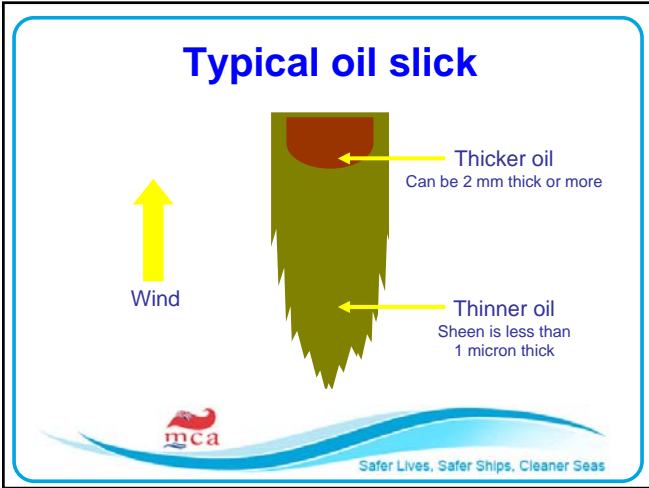


Spreading of spilled oil

- Spilled oil floats and spreads out to form an 'oil slick'
 - Very variable thickness from very thin to thick
 - Sheen that is less than 0.1 microns thick
 - Approximate average of 0.1 mm
- 1 tonne of spilled oil will rapidly spread out to a slick with an area of about 10,000 m²



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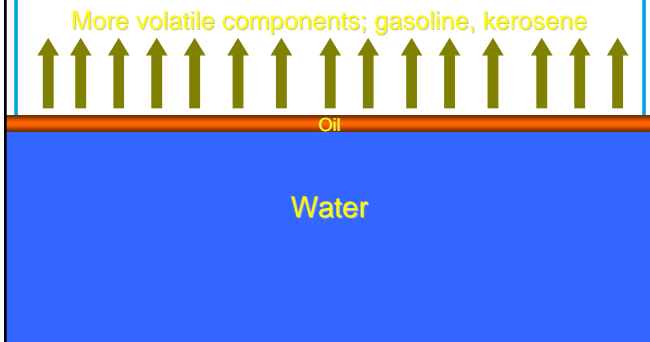
Spreading

- Rate of spreading depends on viscosity
- Waxy oils break into pieces, rather than spread
- Slicks broken up by wind and currents
- Form 'windrows' parallel to wind direction

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Evaporation of volatile oil components



Evaporation

- Volume of oil on the sea surface decreases depending on:
 - Oil composition
 - Temperature
 - Wind speed



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Consequences of evaporation

- As the gasoline evaporates the residue contains more of the high viscosity components
- The viscosity of what is left behind increases
- The oil becomes thicker and more sticky



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Natural dispersion

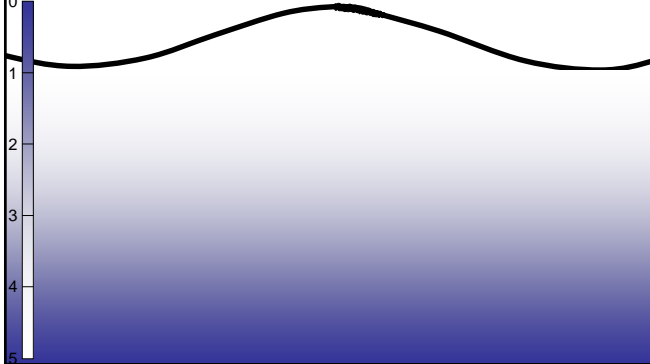
- Natural dispersion requires breaking waves
 - Not a significant process in calm seas
 - Proceeds more rapidly in rough seas
- If natural dispersion continued to completion all the spilled oil would eventually be naturally dispersed and there would be no need for oil spill response



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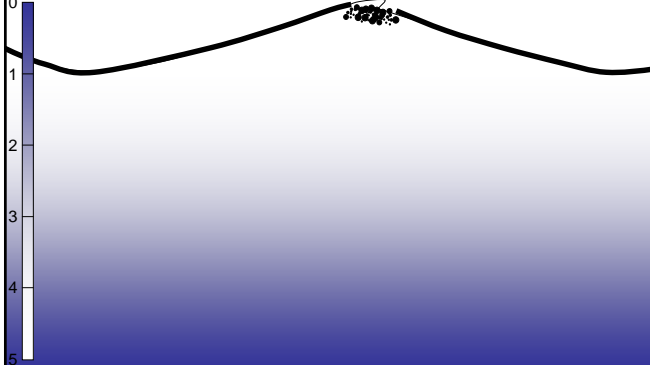
Natural dispersion

Water depth (m)

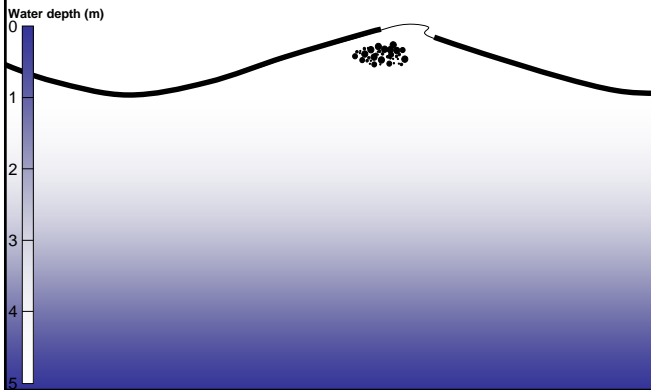


Natural dispersion

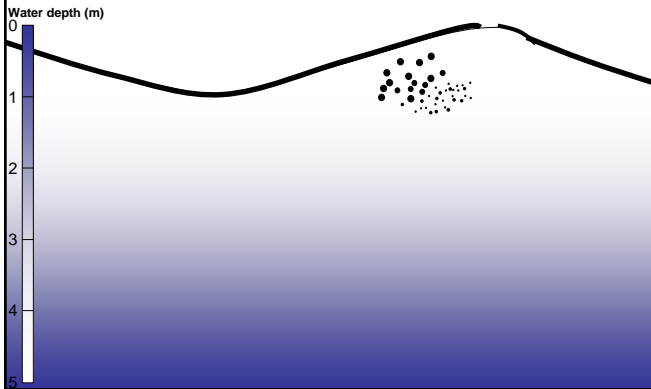
Water depth (m)



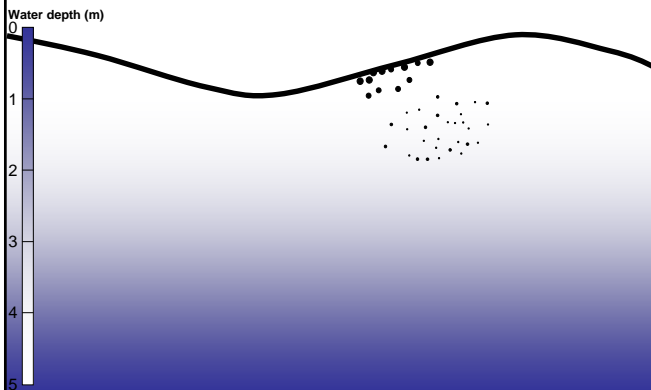
Natural dispersion

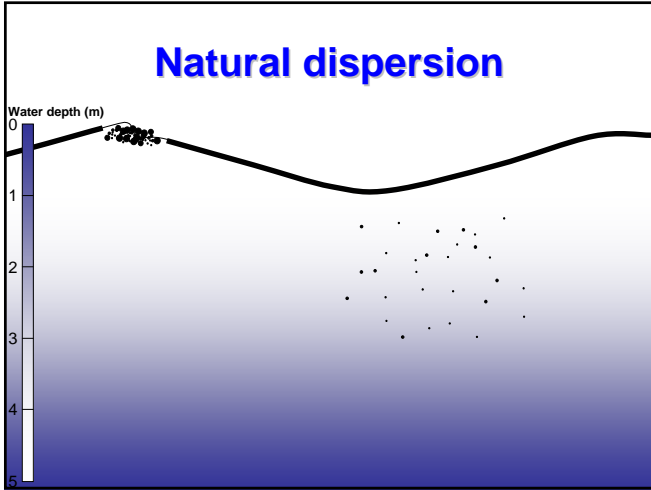


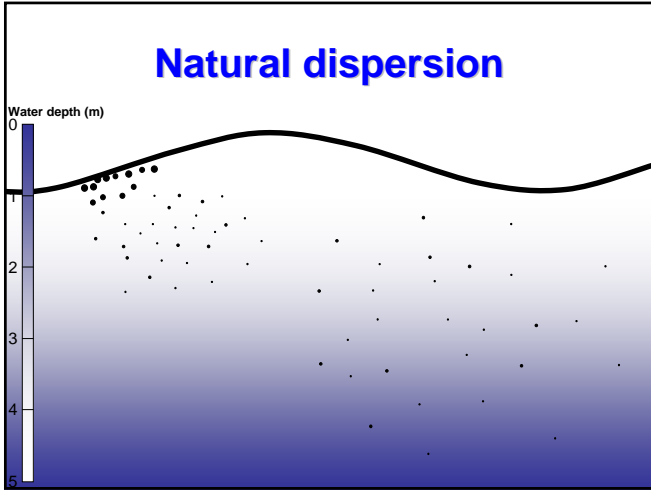
Natural dispersion

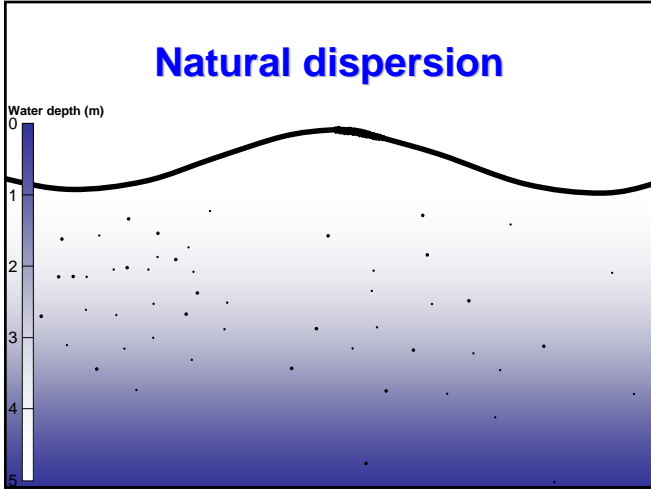


Natural dispersion









Water-in-oil emulsification

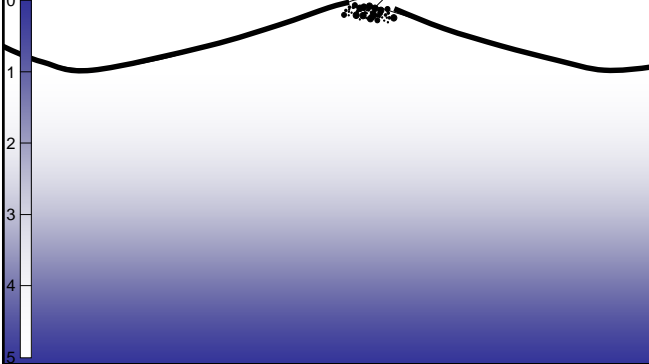
- Water droplets can become incorporated in the body of oil
- Asphaltenes help this emulsification process



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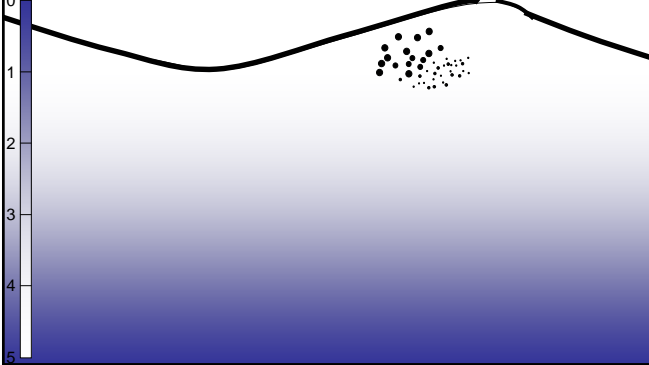
Water-in-oil emulsification

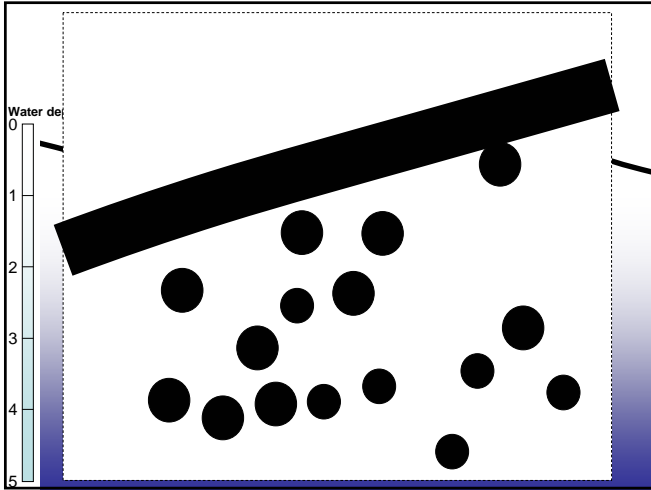
Water depth (m)

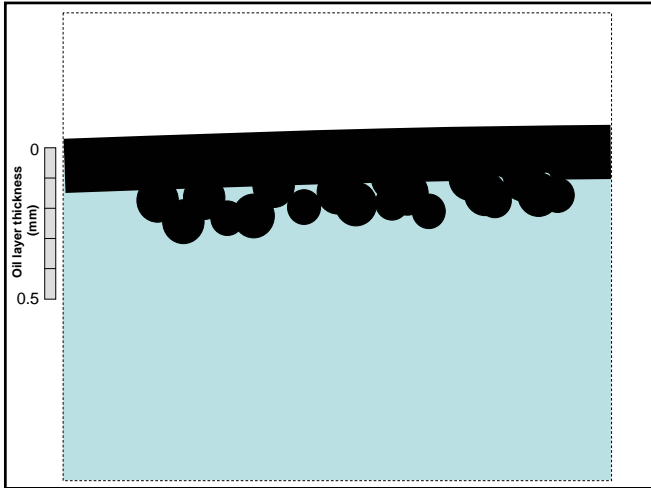


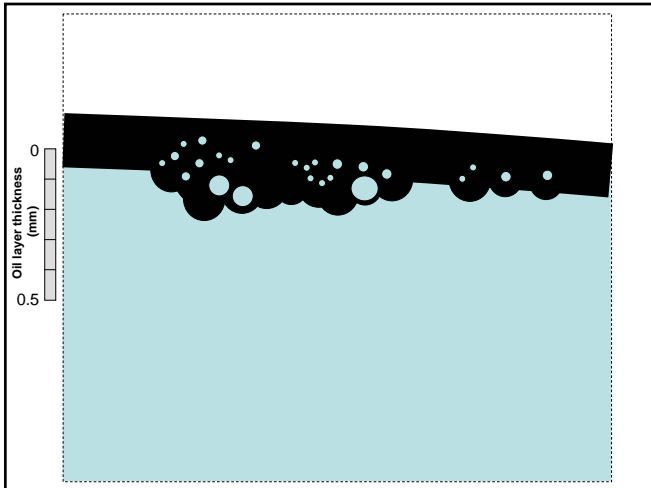
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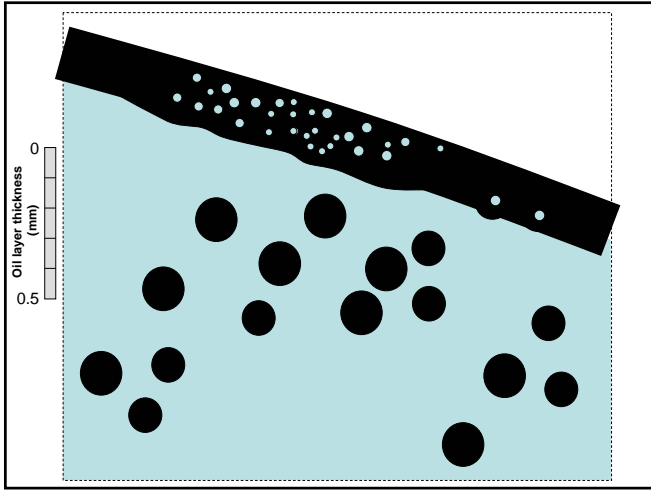
Water depth (m)

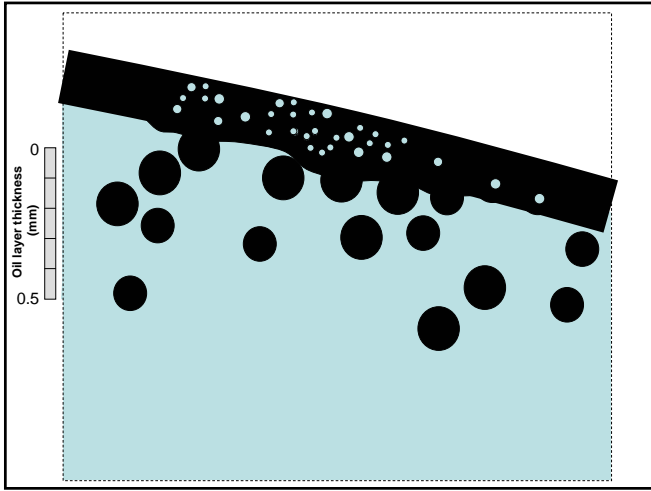


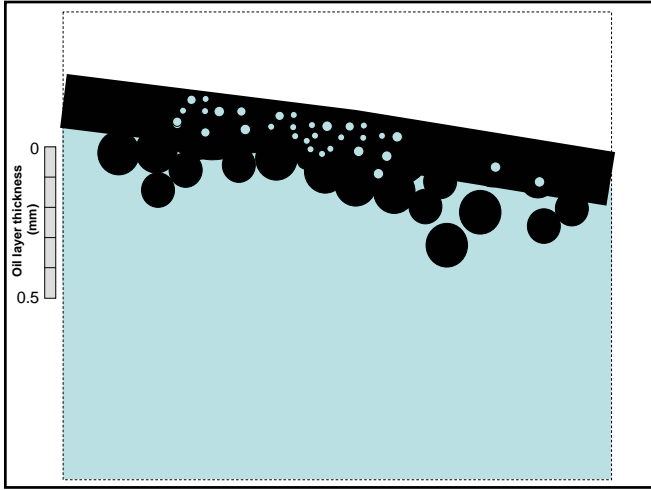


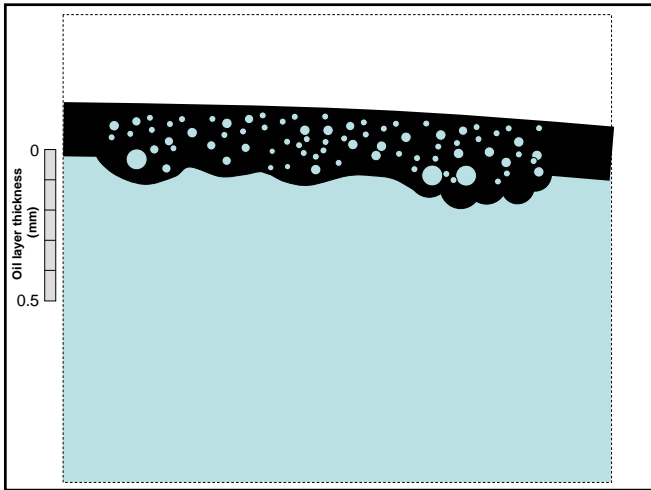


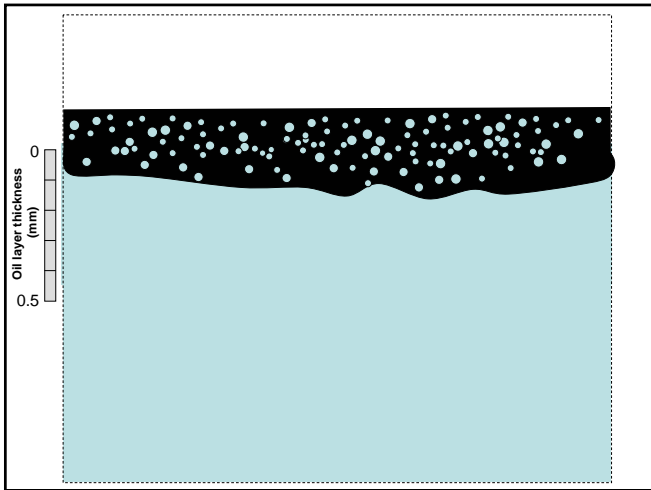


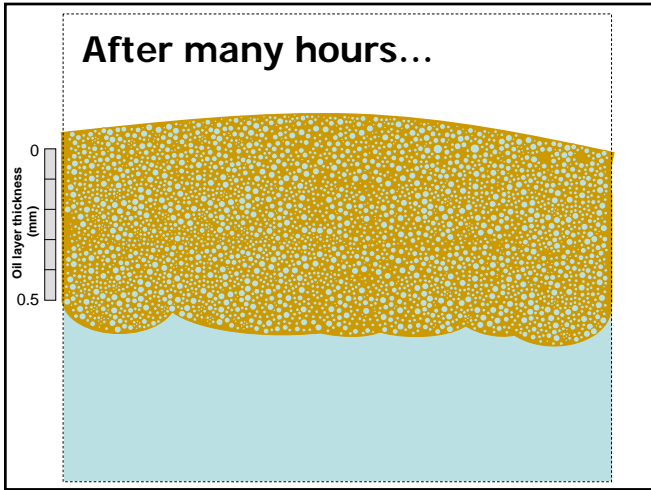


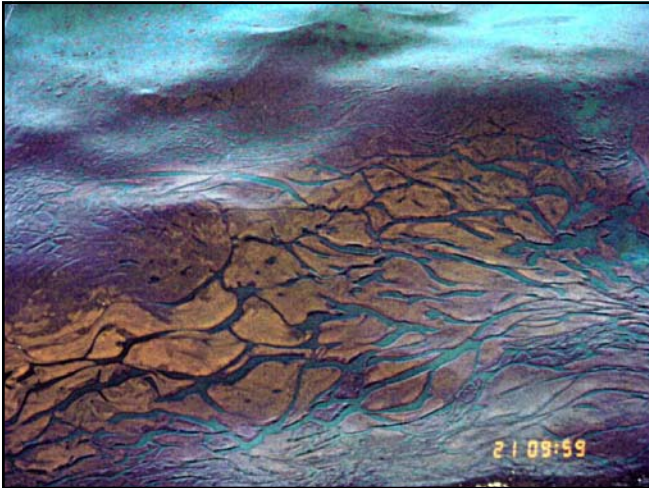












Consequences of emulsification

- Up to 75% volume of water
- Volume of the emulsified oil is 4 times that of residue left after evaporation
- Emulsified oil is much thicker (higher viscosity) than that of oil that was spilled



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An example

- 1,000 tonnes of a light crude oil spilled
 - Spreads out into a slick with an area of approximately 10 km² (10,000,000 m²).
 - 900 tonnes will be in 1 km²
 - Approximately 30% (300 tonnes) will evaporate in 24 hours leaving 700 tonnes
 - Remaining oil will incorporate water to produce 2,800 tonnes of emulsified oil
- 1,000 tonnes spilled, 2,800 tonnes formed



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Other processes

- Dissolution
 - A few oil components dissolve in water
- Oxidation
 - Sunlight and air cause oil to change
- Biodegradation
 - Micro-organisms 'eat' oil if it is dispersed
- Sedimentation
 - If there is suspended sediment



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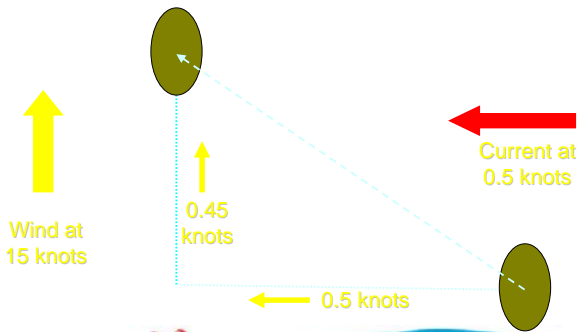
Spilled oil movement

- Oils slicks drift
 - With the current at the speed of the current
 - In the direction of the wind at 3% of wind speed



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Effect of current and wind



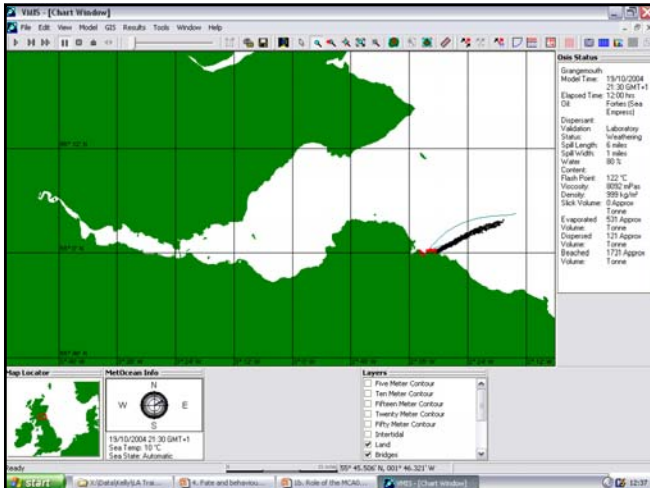
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Computer models predict:

- Oil spill movement:
 - Tidal databases and wind direction and speed input
 - Slick trajectory output
- Oil 'weathering' properties:
 - Oil specific inputs
 - Increase in emulsified oil viscosity output
 - Increase in emulsified oil volume output



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Oil that comes ashore

- Oil that comes ashore becomes mixed up with seaweed, sand etc.
- Great care is needed to prevent picking up a lot of beach material with the oil
 - Best practice will mean oily material contains 25% - 30% oil
 - Bad practice can results in 10% or less oil picked up



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Shoreline clean-up volumes

- 1,000 tonnes of a light crude oil spilled
- 2,800 tonnes emulsified oil comes ashore
- Amount of oil to be disposed of varies:
 - 10,000 tonnes of oily material recovered with best practice
 - 30,000 tonnes of oily material recovered with poor practice



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Any Questions???
