

Fate and Behaviour of Oil



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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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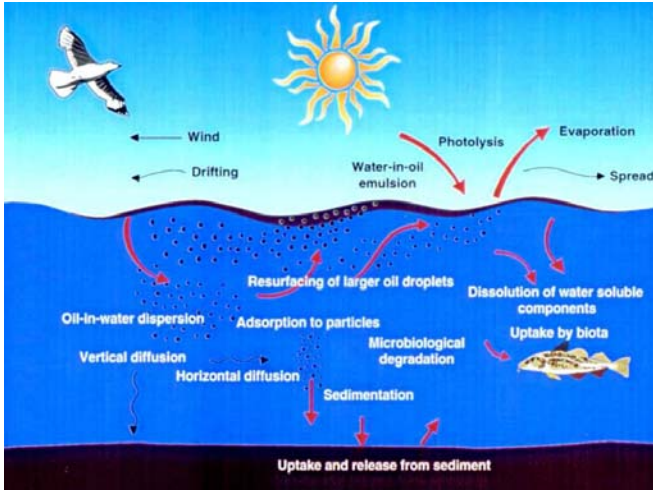












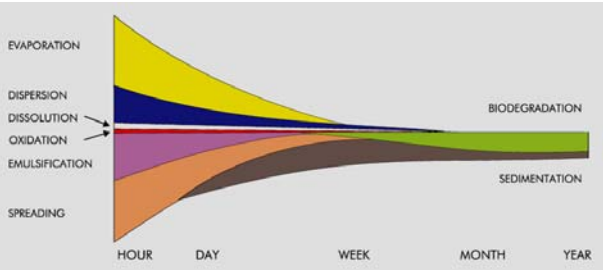
Fate of spilled oil

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



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Process with time



Source: ITOFF



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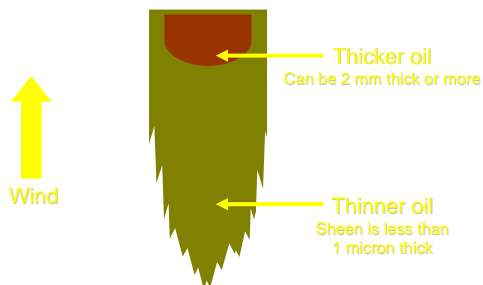
Spreading of spilled oil

- 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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Typical oil slick



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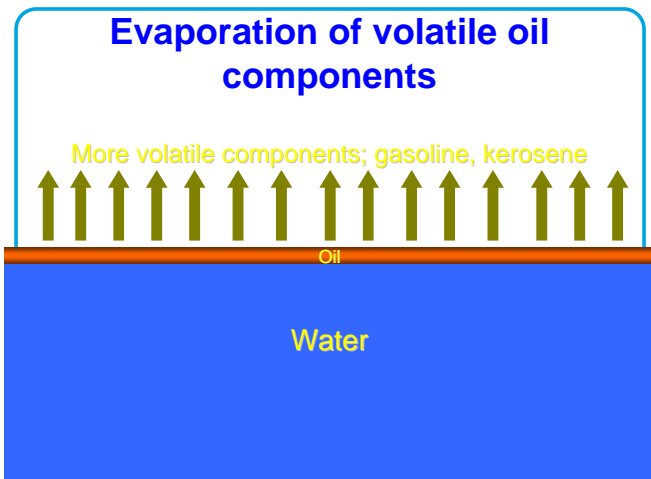
Spreading

- 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

- 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

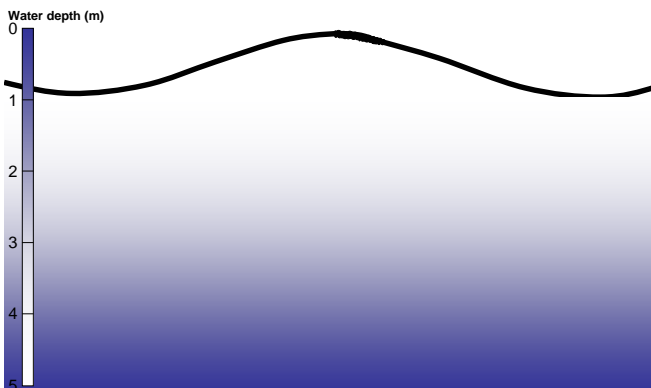


Natural dispersion

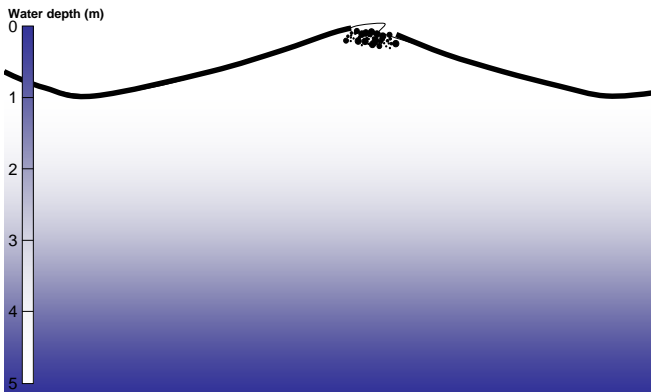
- Natural dispersion requires breaking waves
 - Not a significant process in calm seas
 - Proceeds more rapidly in rough seas
- If natural dispersion continued to completion all the spilled oil would eventually be naturally dispersed and there would be no need for oil spill response



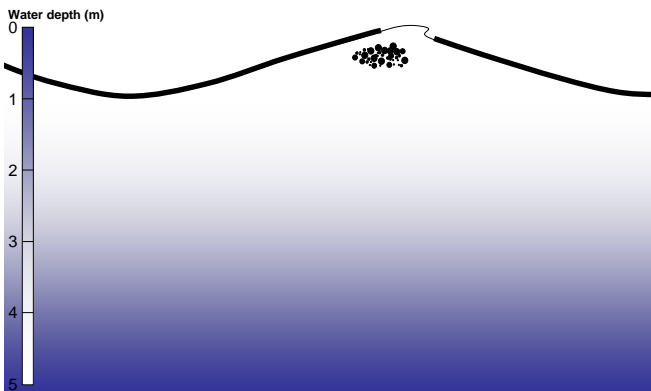
Natural dispersion



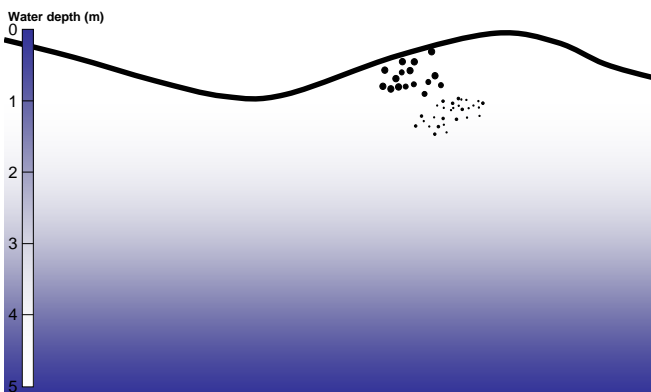
Natural dispersion



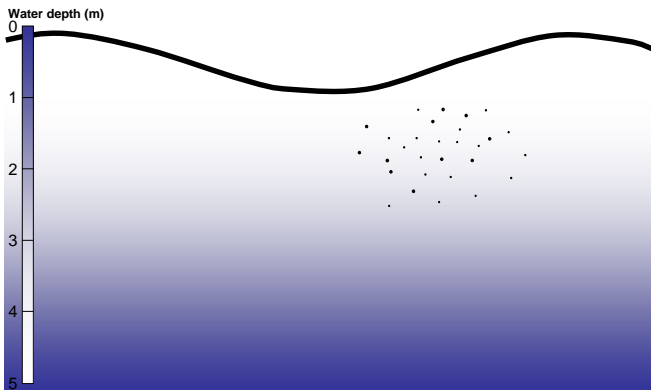
Natural dispersion



Natural dispersion



Natural dispersion

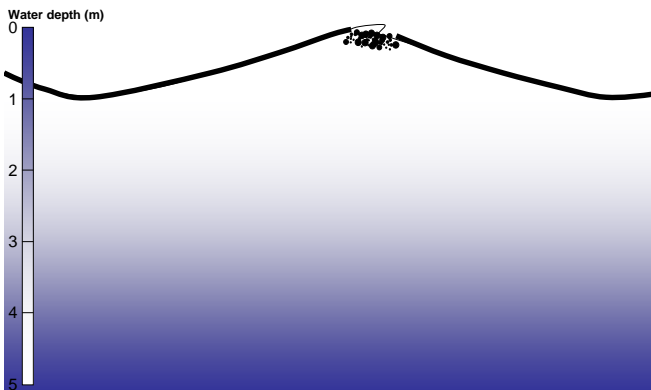


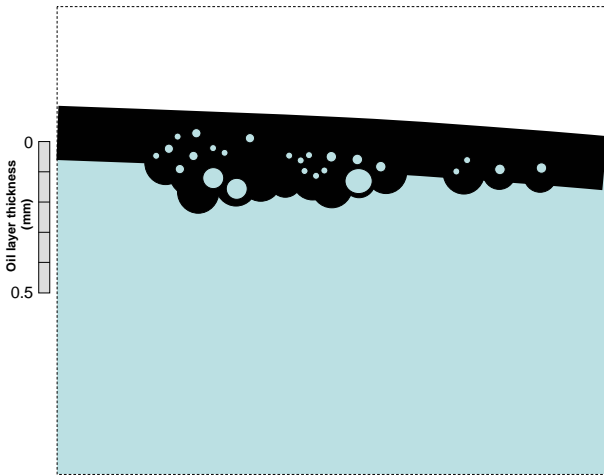
Water-in-oil emulsification

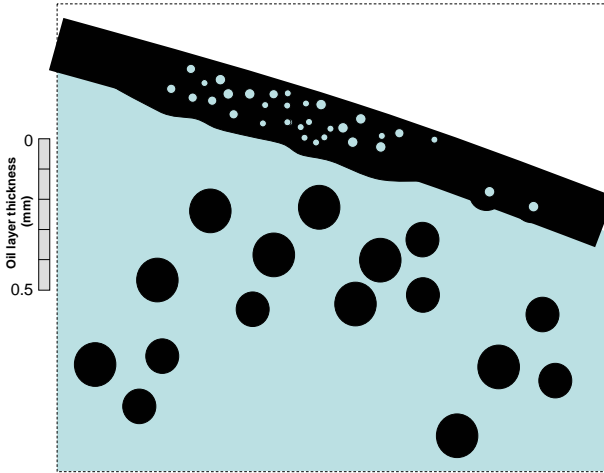
- Water droplets can become incorporated in the body of oil
- Asphaltenes help this emulsification process

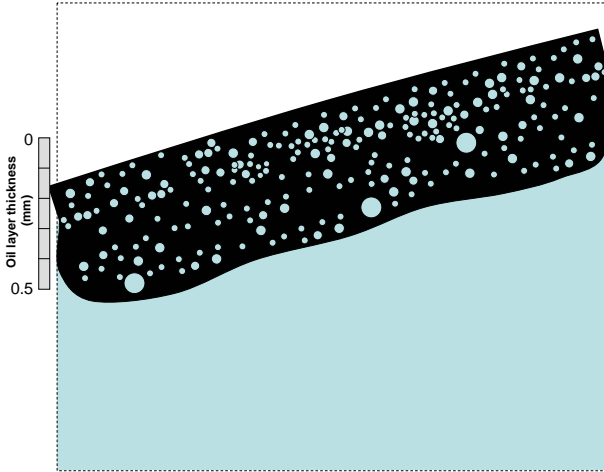


Water-in-oil emulsification

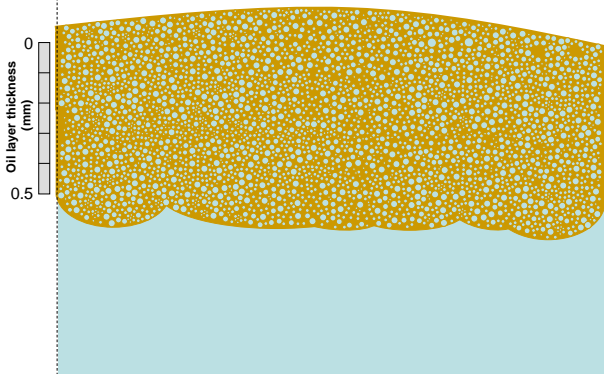


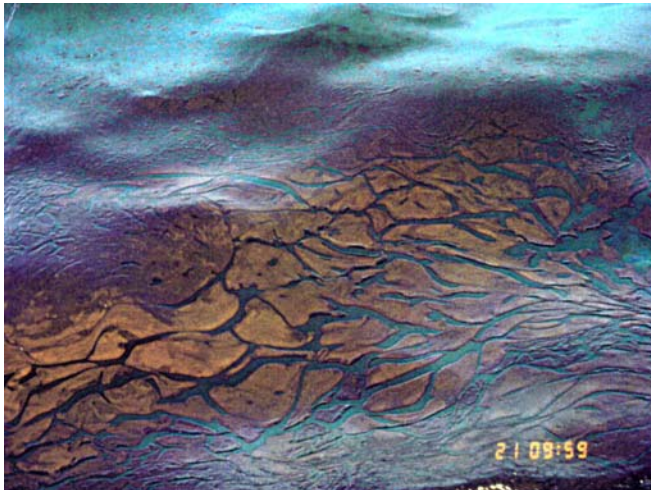






After many hours...





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



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



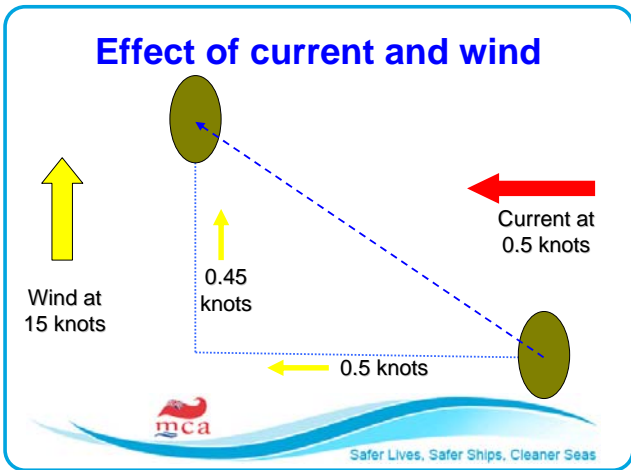
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Spilled oil movement

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



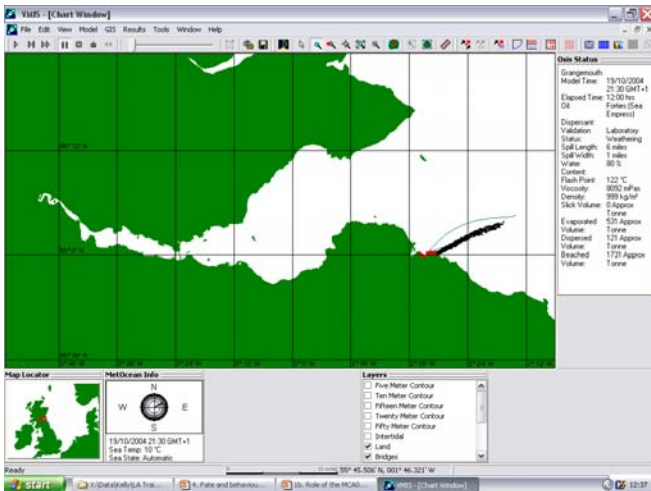
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Computer models predict:

- 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 result 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???
