THE USE OF MULTIBEAM ECHOSOUNDERS FOR OIL AND GAS LEAK DETECTION AND MAPPING

Presented by:

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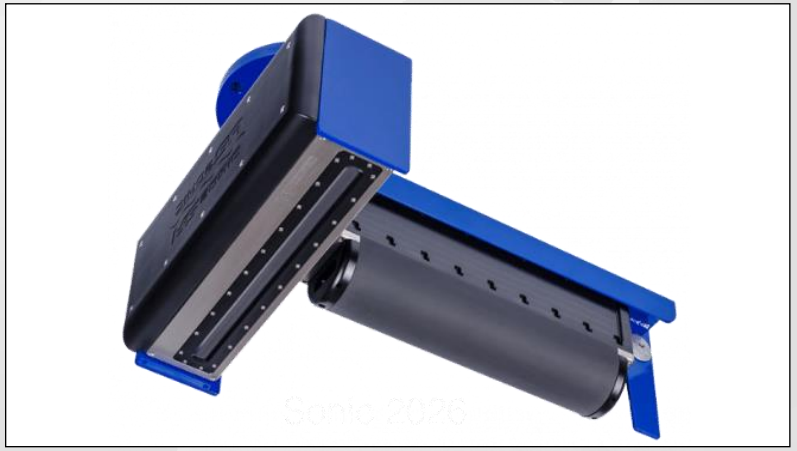
MULTIBEAM ECHOSOUNDER SYSTEMS – (MBES)

KONGSBERG SM 2000 - 1997



R2Sonic 2024

NORBIT WINGHEAD B44

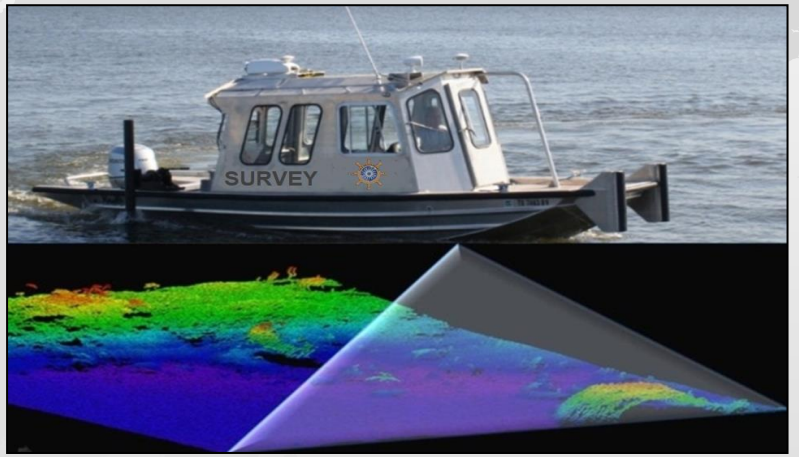
TELEDYNE T-50P

KONGSBERG EM 2040C

SURVEY PLATFORMS

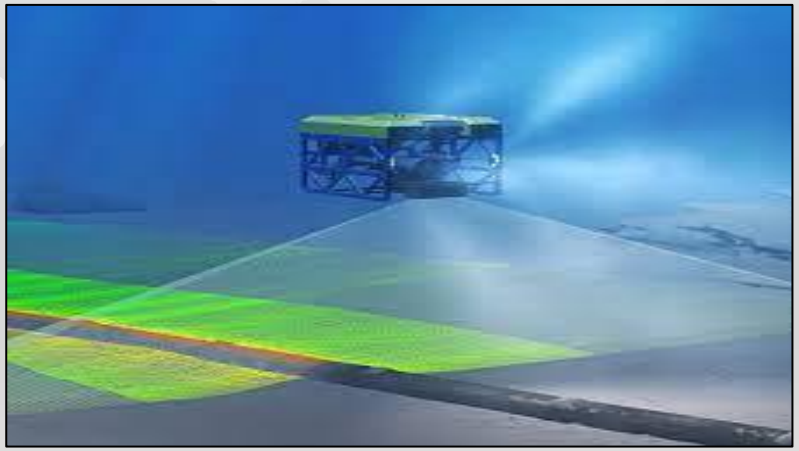
OFFSHORE HYDROGRAPHIC SURVEY VESSELS

COASTAL HYDROGRAPHIC SURVEY VESSELS

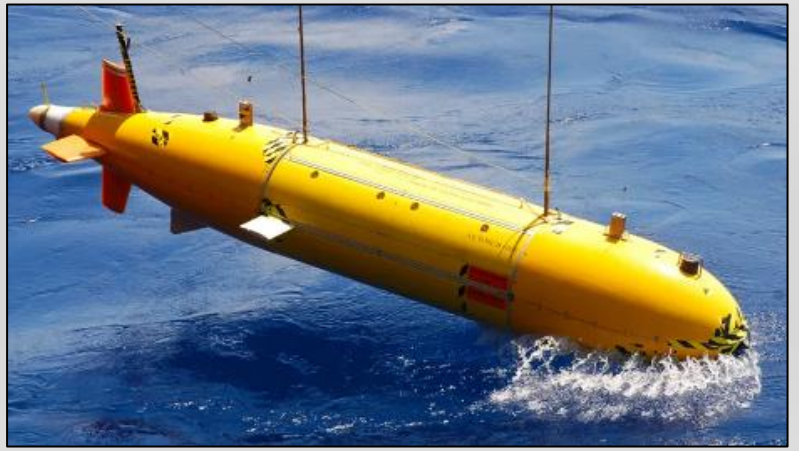


INSHORE HYDROGRAPHIC SURVEY VESSELS

UNMANNED SURFACE VESSELS



REMOTELY OPERATED VEHICLES



AUTONOMOUS UNDERWATER VEHICLES

OPERATING UNDER THE ICE

- MOST INDUSTRY STANDARD MBES CAN BE FITTED TO AN AUTONOMOUS UNDERWATER VEHICLE (AUV)

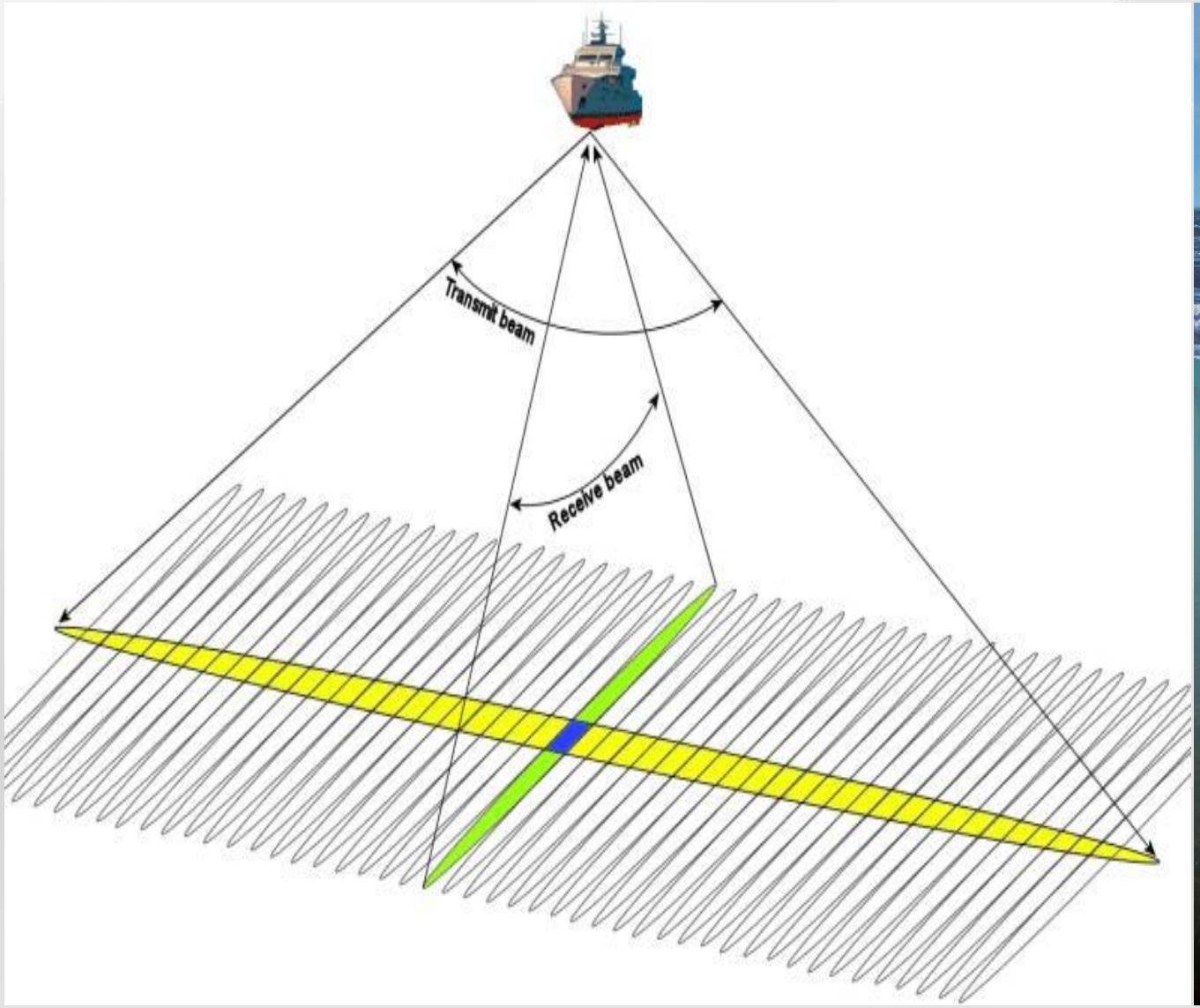
CUT A HOLE IN THE ICE

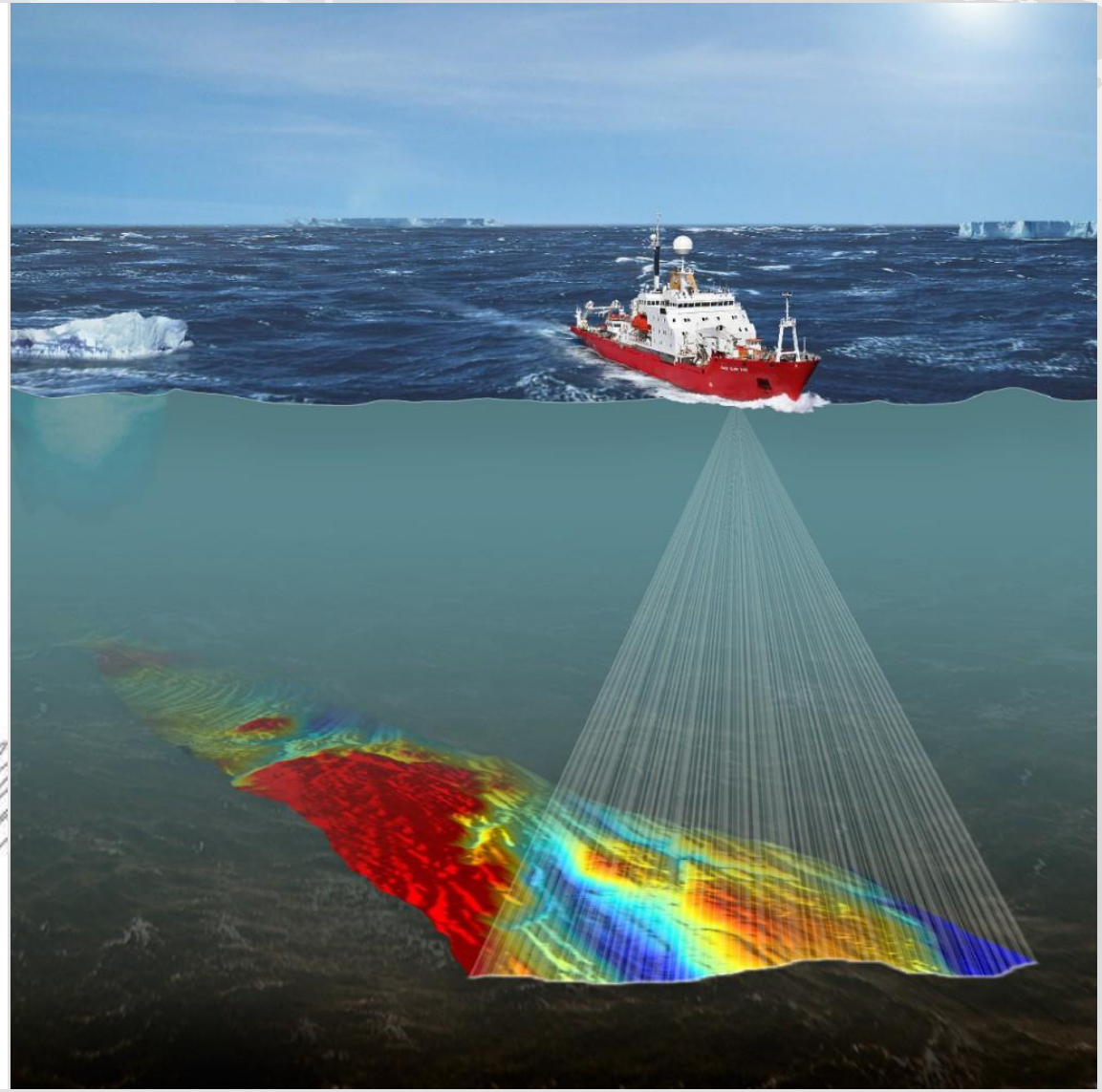
LAUNCH THE AUV

AUV CONDUCTS ITS MISSION

AUV RETURNS TO THE LAUNCH SITE

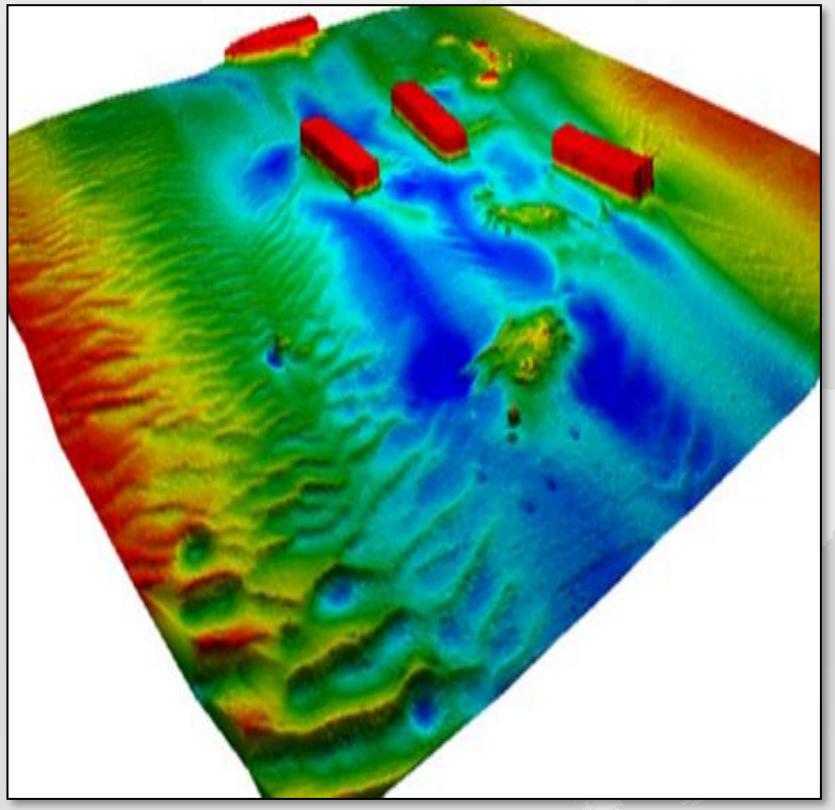
MBES OPERATION



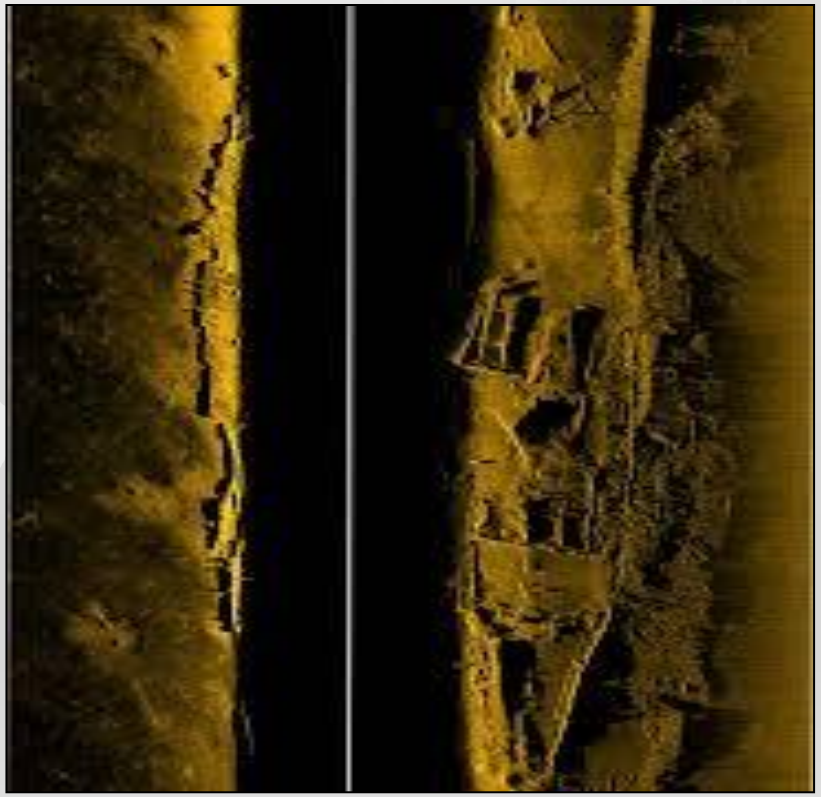


MBES DATA TYPES

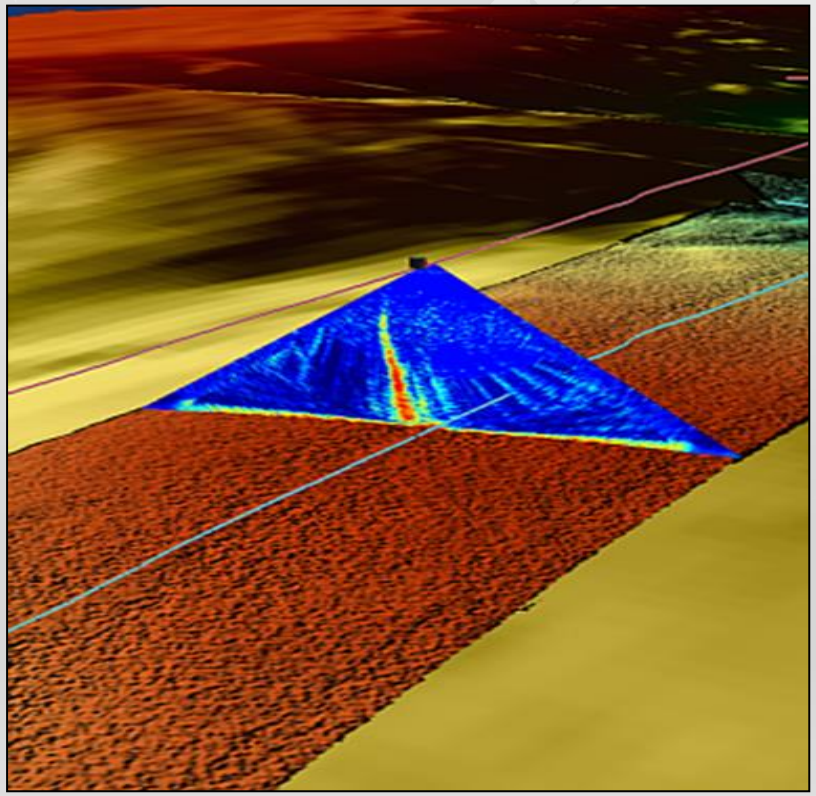
- MBES ARE AN EFFECTIVE SENSITIVE TOOL FOR INVESTIGATING THE SEABED AND THE WATER COLUMN
- THE MAIN ADVANTAGES ARE DETECTION RANGE AND LATERAL COVERAGE
- MBES CAN DETECT THE ACOUSTIC SIGNATURES OF ANY PARTICLES IN THE WATER COLUMN - (BACKSCATTER)
- BOTTOM TRACKING ALGORITHMS NEGATE BACKSCATTER TO PRODUCE A CLEAN MODEL OF THE SEABED
- IN MOST CASES THE WATER COLUMN DATA IS DISCARDED



3D BATHYMETRY



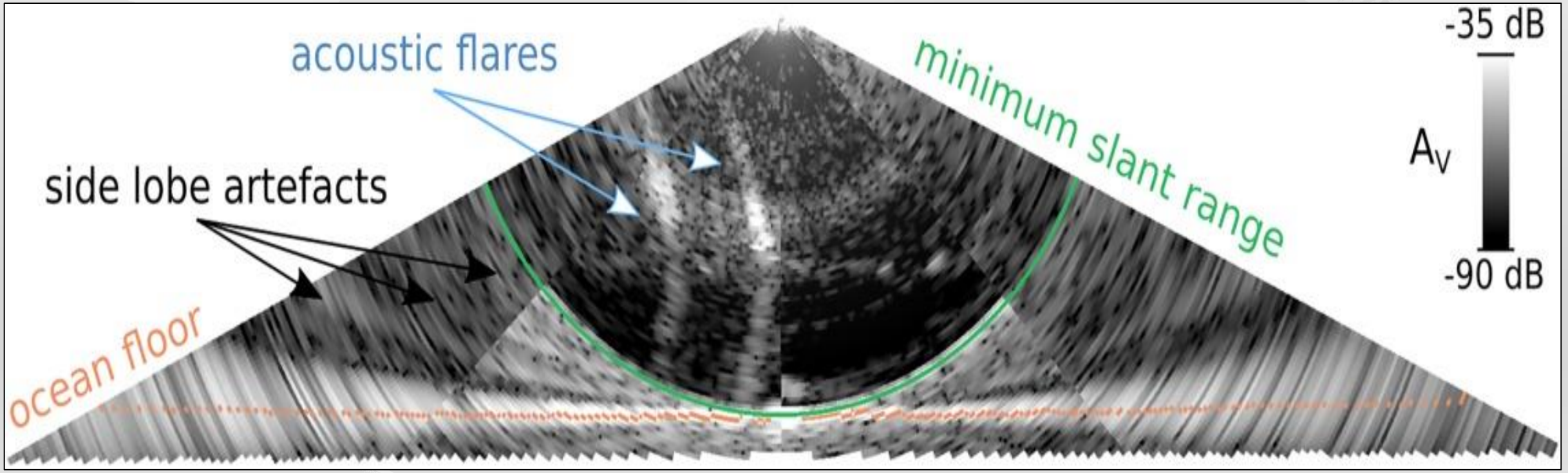
BACKSCATTER SIDE SCAN



WATER COLUMN DATA

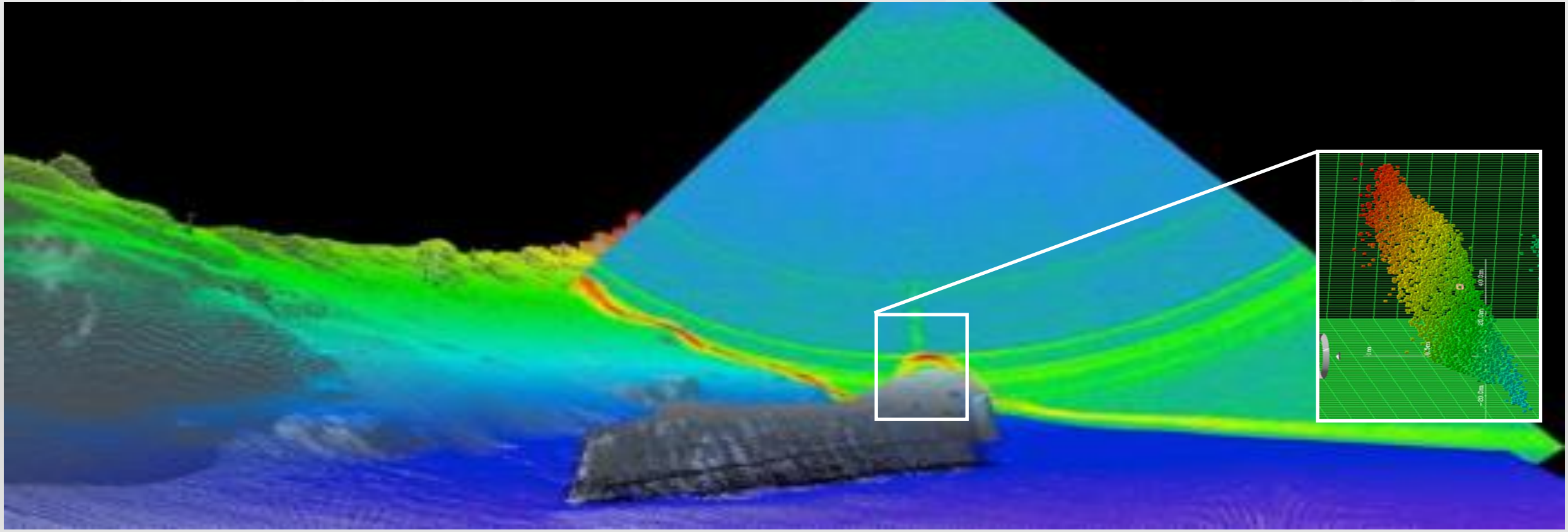
WATER COLUMN DATA PROCESSING

- 1997 - SIMRAD SM2000, 2002 - FIRST 3D VISUALIZATION, 2023 – COMMONPLACE
- SIDE-LOBE INDUCED SIGNAL INTERFERENCE CREATES SYSTEMATIC ARTEFACTS
- SYSTEMATIC ARTEFACTS AND HIGH NOISE LEVELS PRODUCE HUGE DATA SETS
- OIL & GAS LEAKS AND SEEPS APPEAR IN THE DATA AS ACOUSTIC FLARES
- POWERFUL COMPUTERS AND SPECIALIZED SOFTWARE CAN SEPARATE THE ACOUSTIC SIGNATURES OF THE FLARES FROM THE SYSTEMATIC NOISE



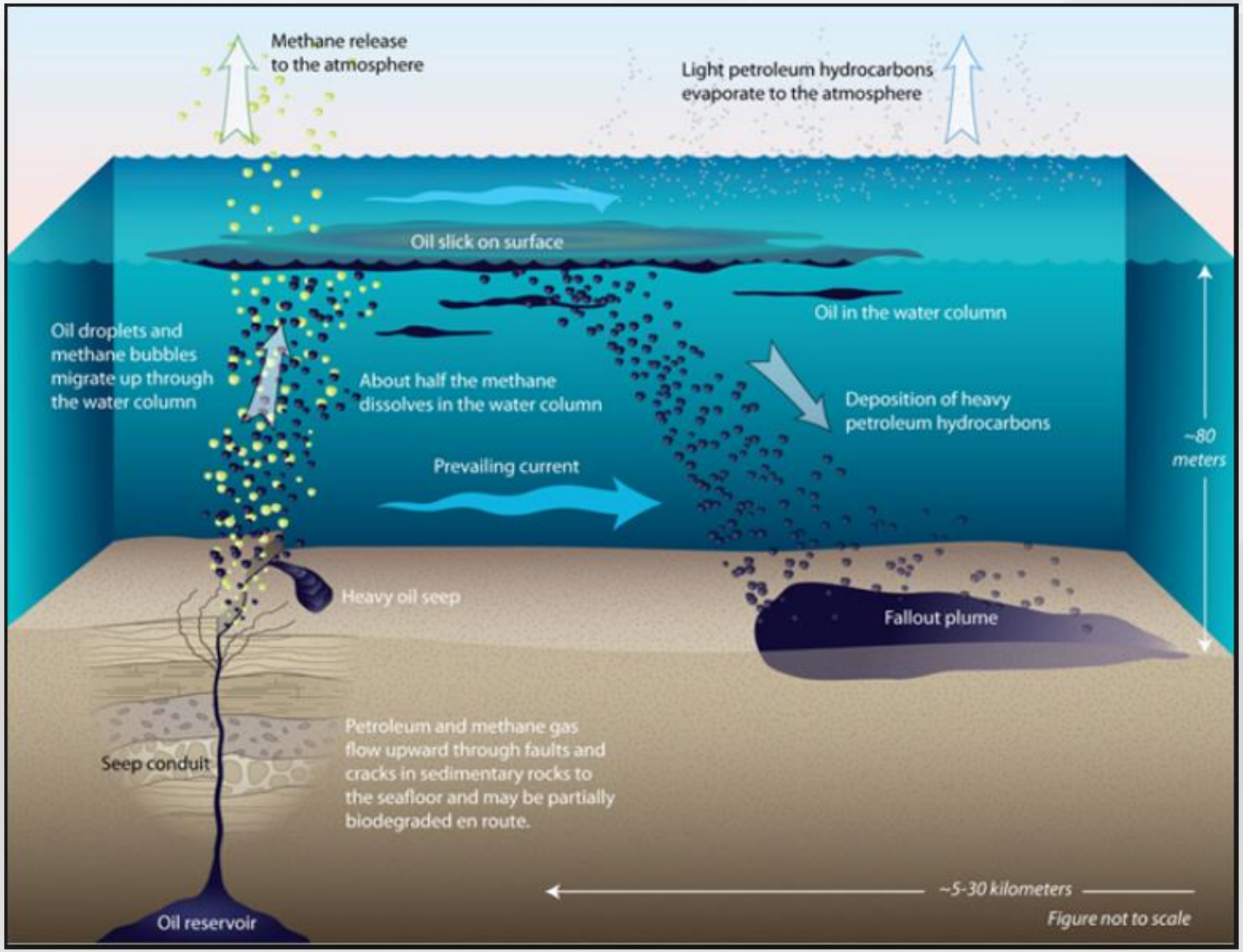
WATER COLUMN DATA PROCESSING

- MODERN MBES SYSTEMS CAN VISUALIZE THE WATER COLUMN IN REAL-TIME
- SOFTWARE CAN BE CONFIGURED TO DETECT SPECIFIC ACOUSTIC SIGNATURES
- HUGE DATA SETS CAN BE PROCESSED SEMI-AUTOMATICALLY
- LEAKS AND SEEPS CAN BE QUANTIFIED USING 4D PROCESSING TECHNIQUES
- THE SOLUTION IS VERY EFFICIENT AND COST EFFECTIVE



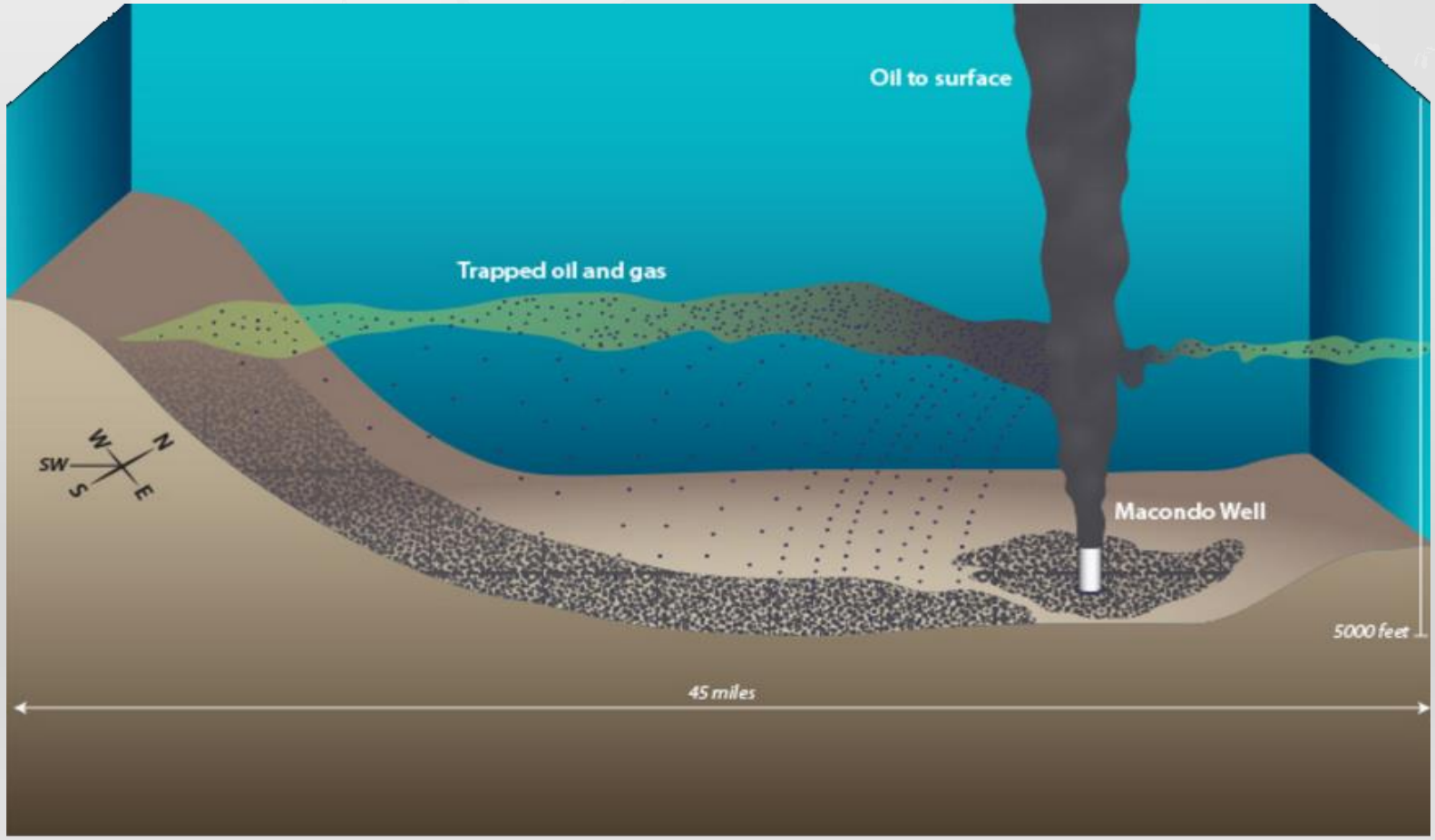
SUB SURFACE OIL PLUMES

- **EXPLANATION OF SUB SURFACE OIL PLUMES**

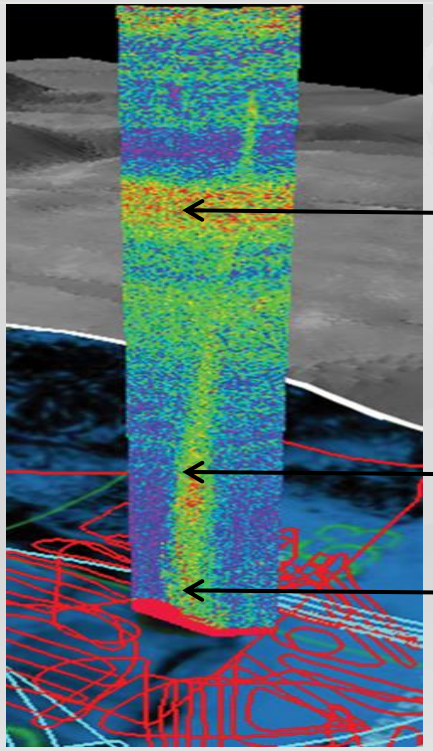


WATER COLUMN DATA PROCESSING

- **DEEP WATER HORIZON – MACONDO WELL - 2010**
  - 200 MILLION GALLONS OF CRUDE OIL DISCHARGED INTO THE ENVIRONMENT
  - HALF NEVER SURFACED TO FORM SLICKS BUT REMAINED TRAPPED DEEP IN THE OCEAN
  - SOME REMAINED TRAPPED IN THE WATER COLUMN AND WAS CIRCULATED BY OCEAN CURRENTS
  - SOME SANK INTO SEAFLOOR SEDIMENTS



WATER COLUMN DATA



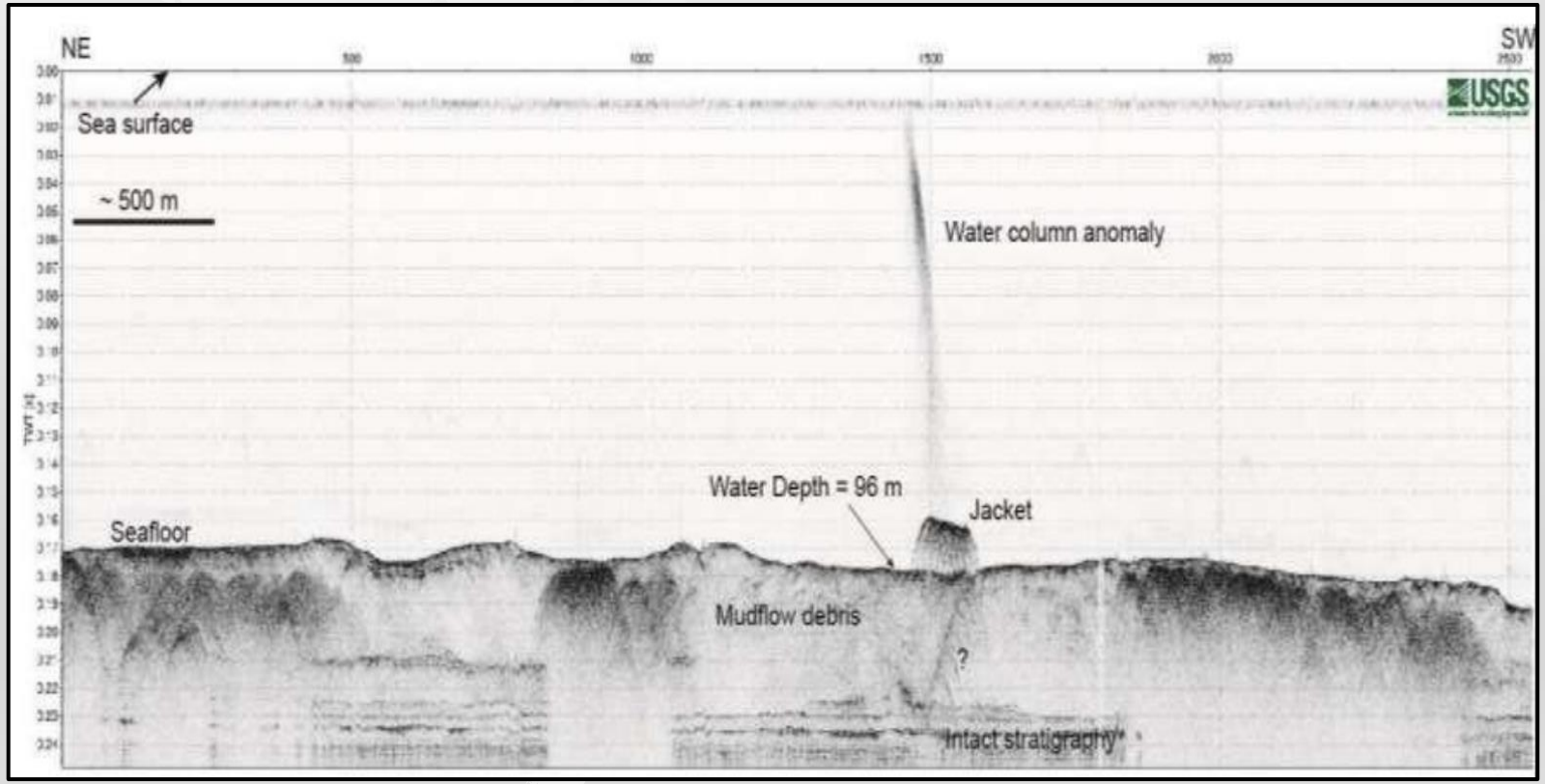
TRAPPED OIL & GAS

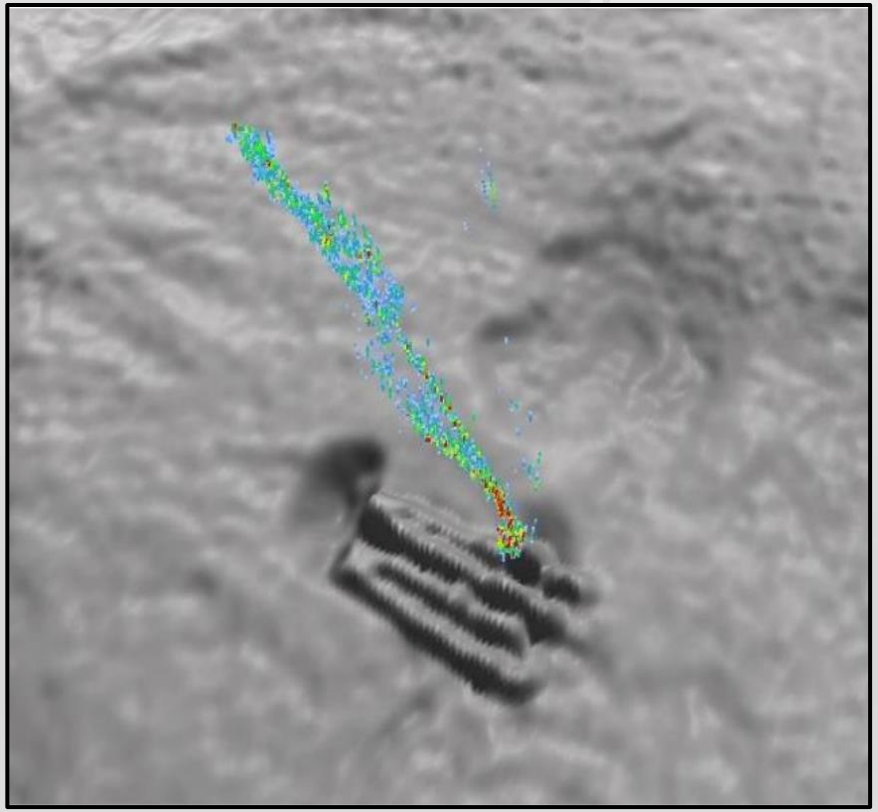
OIL PLUME

MACONDO WELL

TAYLOR ENERGY MC-20 EXAMPLE

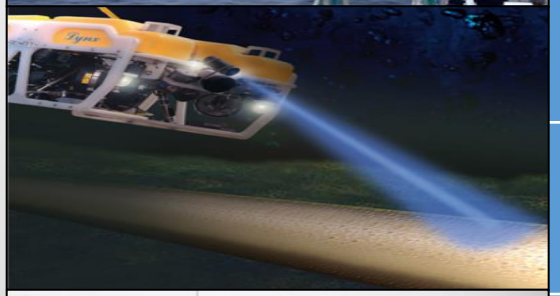
- **SUB-BOTTOM PROFILERS**
  - ***PENETRATES 100's FEET BENEATH THE SEABED***
  - ***CAN DISTINGUISH BETWEEN SEDIMENTS***
  - ***ABLE TO DETECT OIL LYING ON / BENEATH THE SURFACE***
  - ***ABLE TO DETECT PLUMES IN THE WATER COLUMN***
  - ***USED TO ENHANCE MULTIBEAM WATER COLUMN DATA***

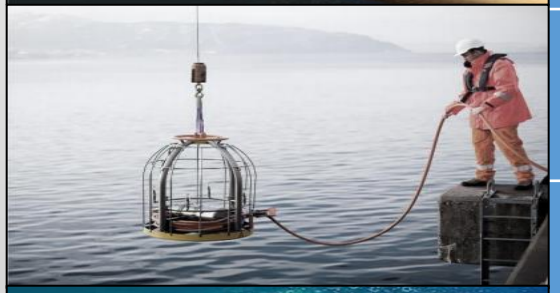


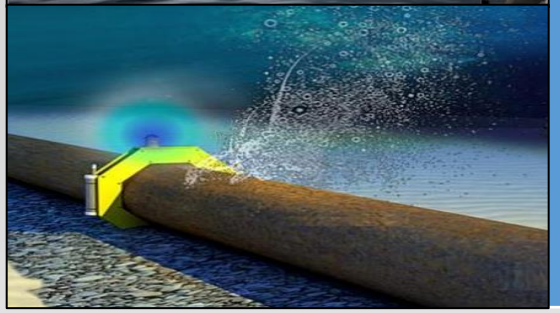


Sub-Bottom Profiler Data (Left) Multibeam Water Column Data (Right) – Taylor Energy MC-20, 2010

LEAK DETECTION – METHODS SUMMARY



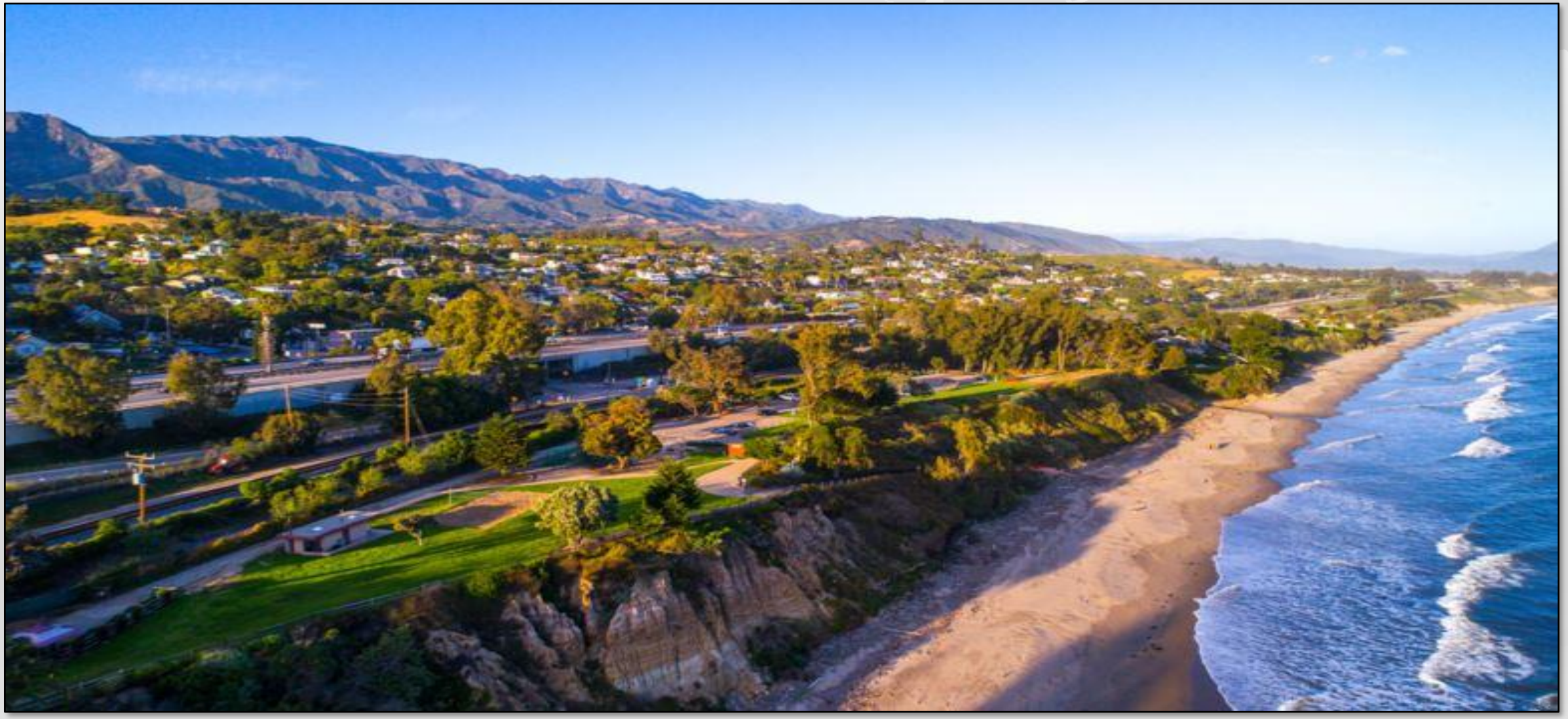




METHOD	ADVANTAGES	DISADVANTAGES
Methane Detectors	• Very sensitive	• Short Ranges • Slow detection times
Fluorescence Detectors	• Provides indication of leak size • Less restricted by depth • Fluid differentiation	• Requires visual observations • Restricted by water turbidity • Requires ROV
Temperature Sensors and Mono-Ethylene Glycol (MEG)	• High sensitivity • Fast response times	• No material differentiation • Cold Deep Water is difficult
Passive Acoustic Detection	• Not Material dependent on • Can detect exact location • No affected by turbidity.	• Poor results in noisy areas • Cannot identify small leaks
Multibeam Sonar	• Works in any type of water • Long range detection ability • Very fast over long distances • Can differentiate materials • Can pinpoint locations • Can quantify flow rates • Very Cost Effective	• Huge amounts of data • Significant processing required

EXAMPLE PROJECTS

- **PROJECT REQUIREMENTS**
  - ***INVESTIGATE THE SOURCE OF SURFACE OIL AND OILY DEPOSITS ON THE BEACH***



EXAMPLE PROJECTS

- **VISUAL INSPECTION**
  - ***SMALL UNMANNED AERIAL VEHICLE (sUAV) SURVEY***

EXAMPLE PROJECTS

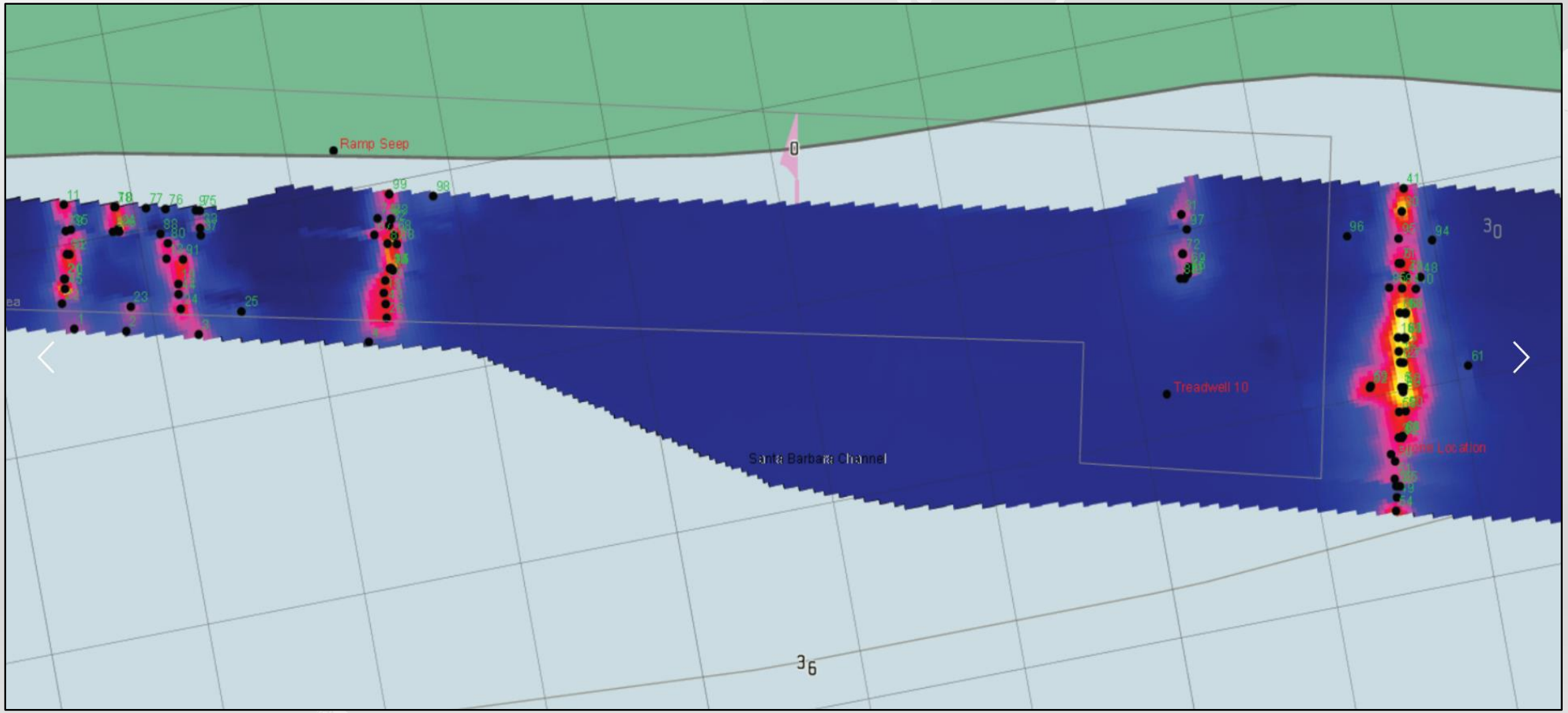
- **MAGNETOMETER SURVEY**
  - ***MAGNETOMETER WAS TOWED ON FLOATS DUE TO SHALLOW WATER IN THE SURVEY AREA***

EXAMPLE PROJECTS

- **MAGNETOMETER SURVEY**
  - ***MAGNETOMETER SURVEY OF THE PROPOSED SURVEY AREA***

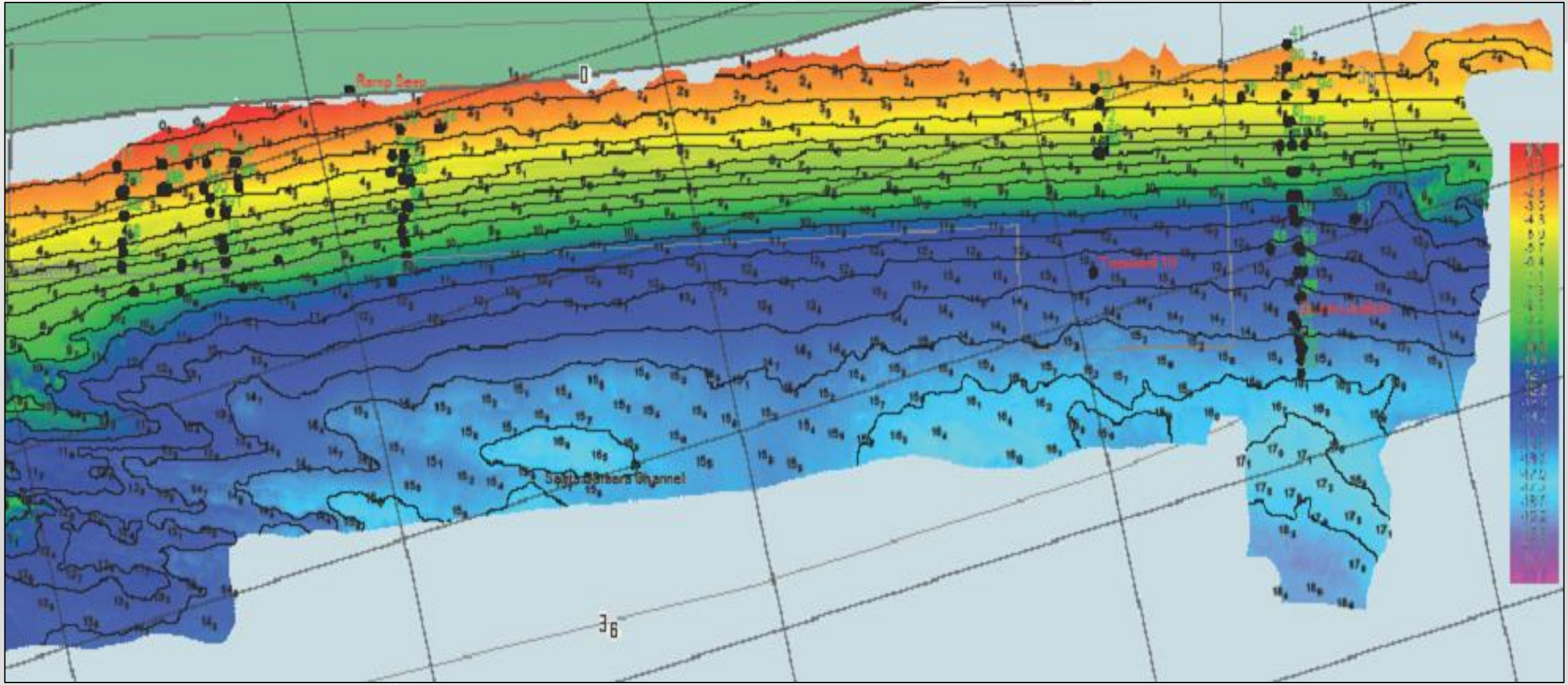
EXAMPLE PROJECTS

- **MAGNETOMETER SURVEY**
  - ***MAGNETOMETER HEAT MAP***



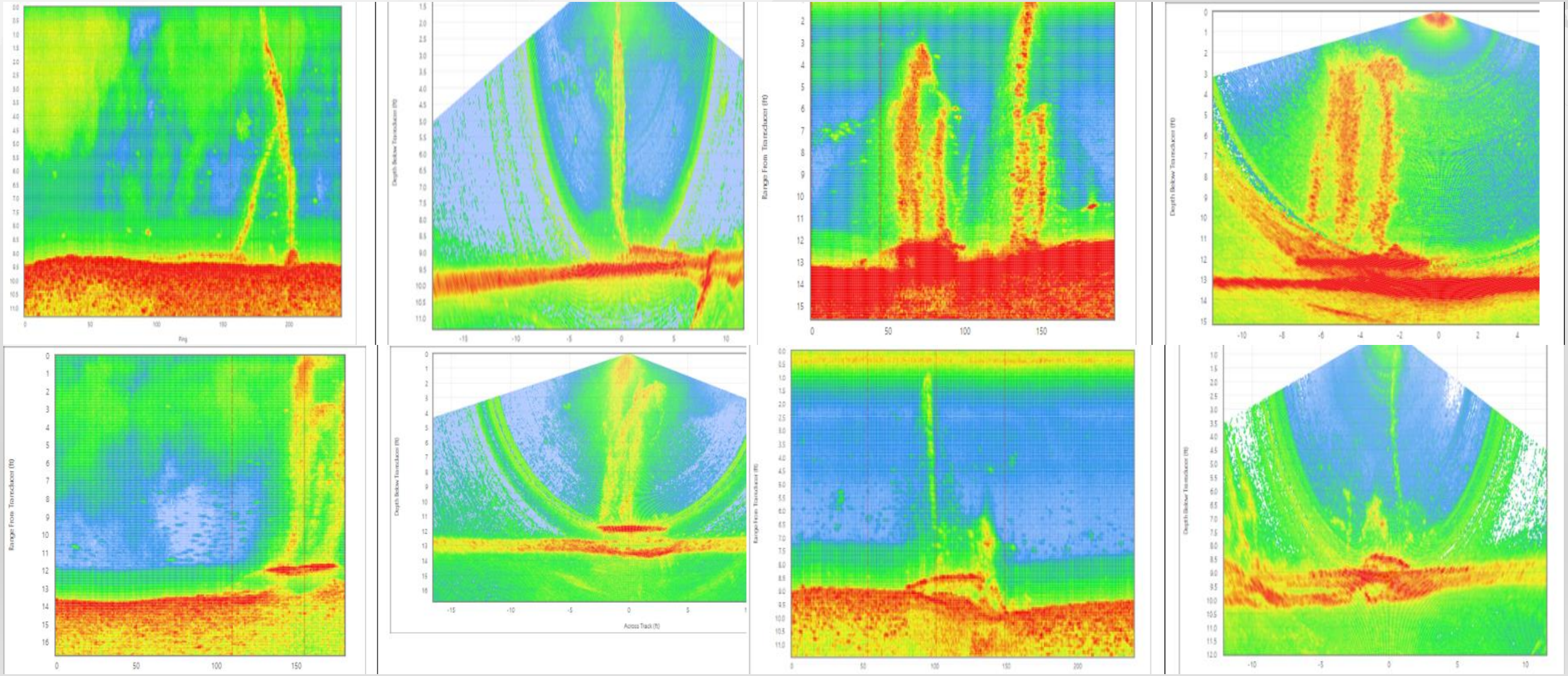
EXAMPLE PROJECTS

- **BATHYMETRY SURVEY**
  - ***MULTIBEAM ECHOSOUNDER SURVEY OF THE PROPOSED SURVEY AREA – RECORDING WATER COLUMN DATA***



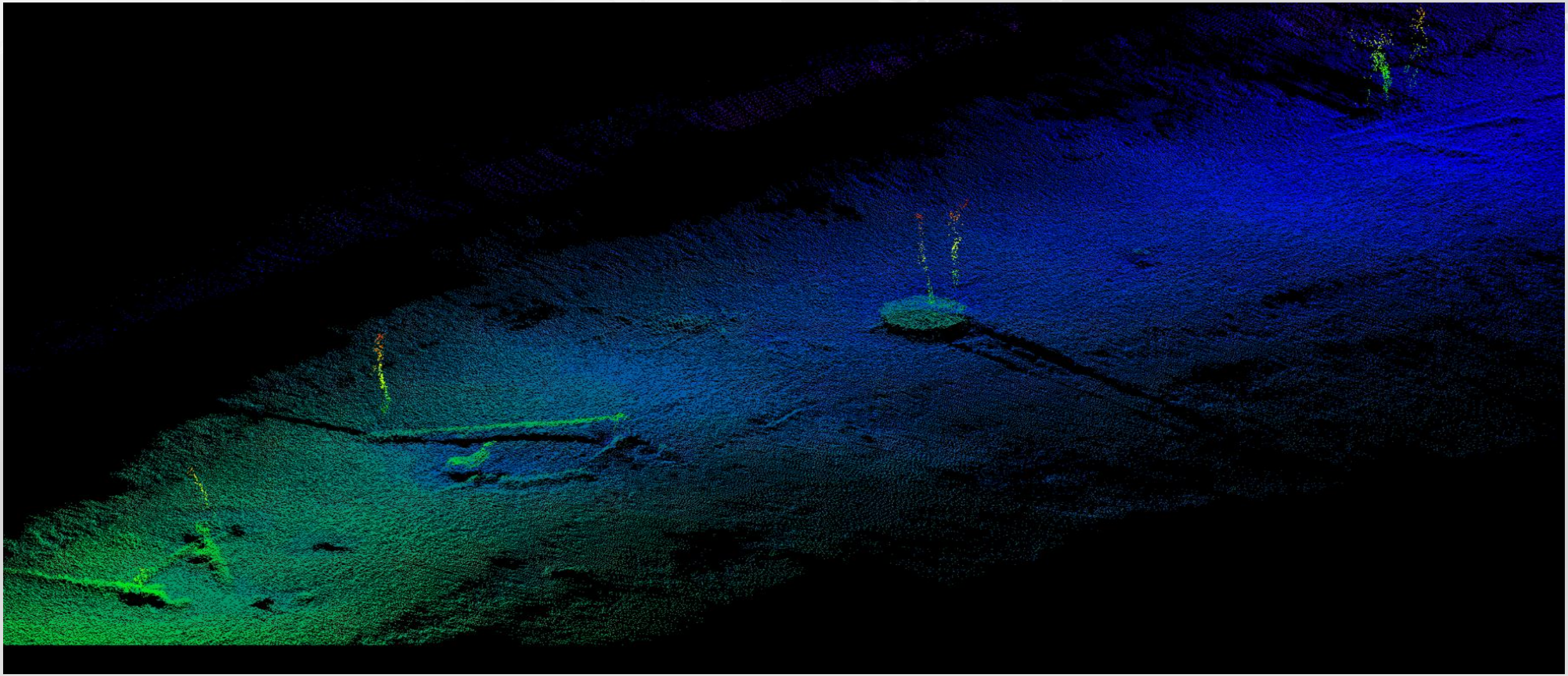
EXAMPLE PROJECTS

- **WATER COLUMN DATA**
  - ***PROCESSING THE MULTIBEAM ECHOSOUNDER WATER COLUMN DATA***



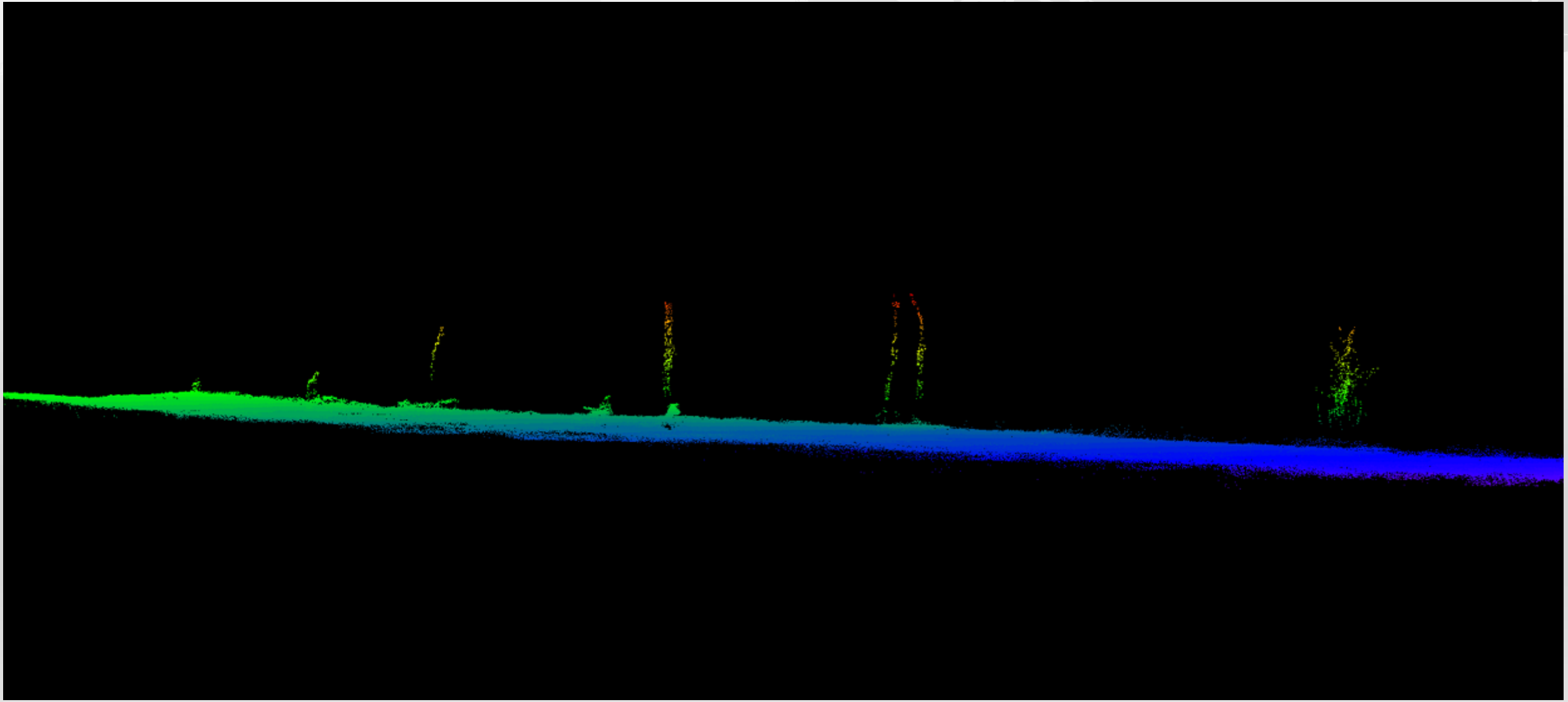
EXAMPLE PROJECTS

- **3D DATA VISUALIZATION**
  - ***OIL SEEPING FROM DERELICT PIPELINES AND WELLHEADS***



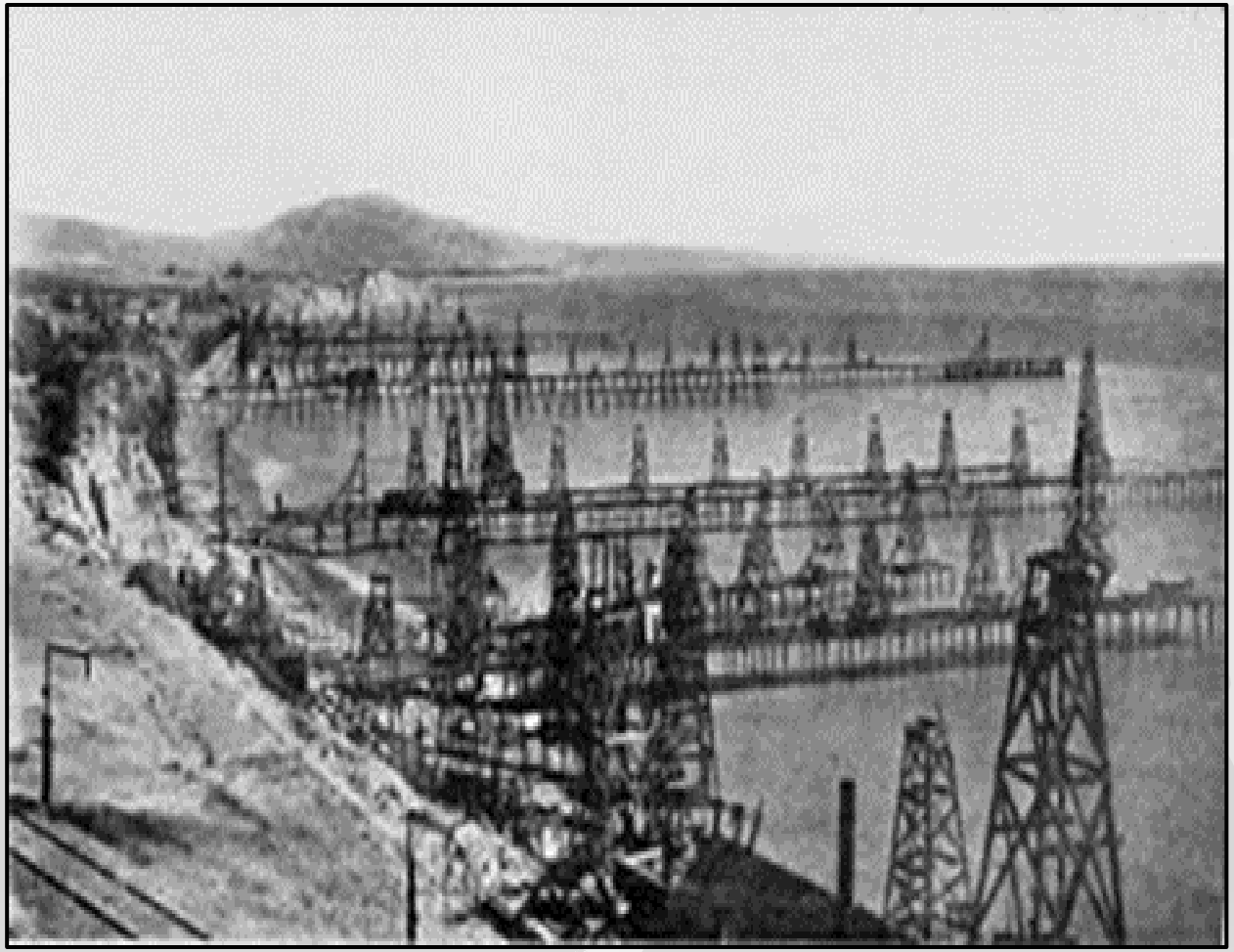
EXAMPLE PROJECTS

- **3D DATA VISUALIZATION – PROFILE VIEW**
  - ***OIL SEEPING FROM DERELICT PIPELINES AND WELLHEADS***



EXAMPLE PROJECTS

- **ARCHIVE SEARCH**
  - ***INVESTIGATE THE SOURCE OF SURFACE OIL AND OILY DEPOSITS ON THE BEACH, SUMMERLAND, CA***

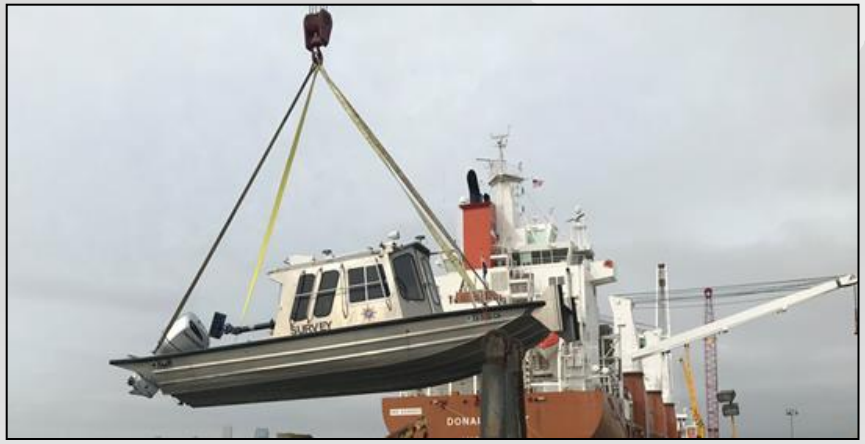


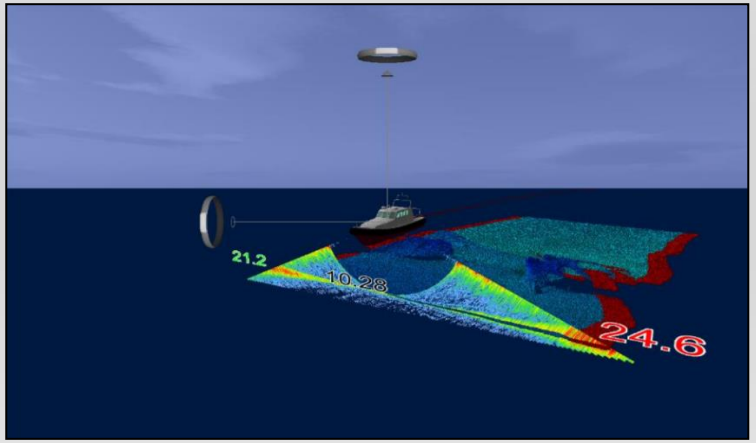
California's first offshore oil wells, – (Pre-1906)

The same view of today

CONCLUSIONS

- PROCESSING MULTIBEAM WATER COLUMN DATA IS AN EFFECTIVE LEAK DETECTION SOLUTION
- CAN BE MOBILIZED ONTO ALMOST ANY SURVEY PLATFORM
- THE SYSTEM IS ABLE TO DETECT ANY FOREIGN MATTER IN THE WATER COLUMN
- SMALL VOLUMES CAN BE DETECTED AT LONG RANGES
- LARGE AREAS CAN BE COVERED QUICKLY
- THE LOCATION OF LEAKS CAN BE PRECISELY DETERMINED
- VOLUMES AND FLOW RATES CAN BE CALCULATED
- VERY COST-EFFECTIVE SOLUTION – NO REQUIREMENT FOR DIVER OR ROV SUPPORT





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