

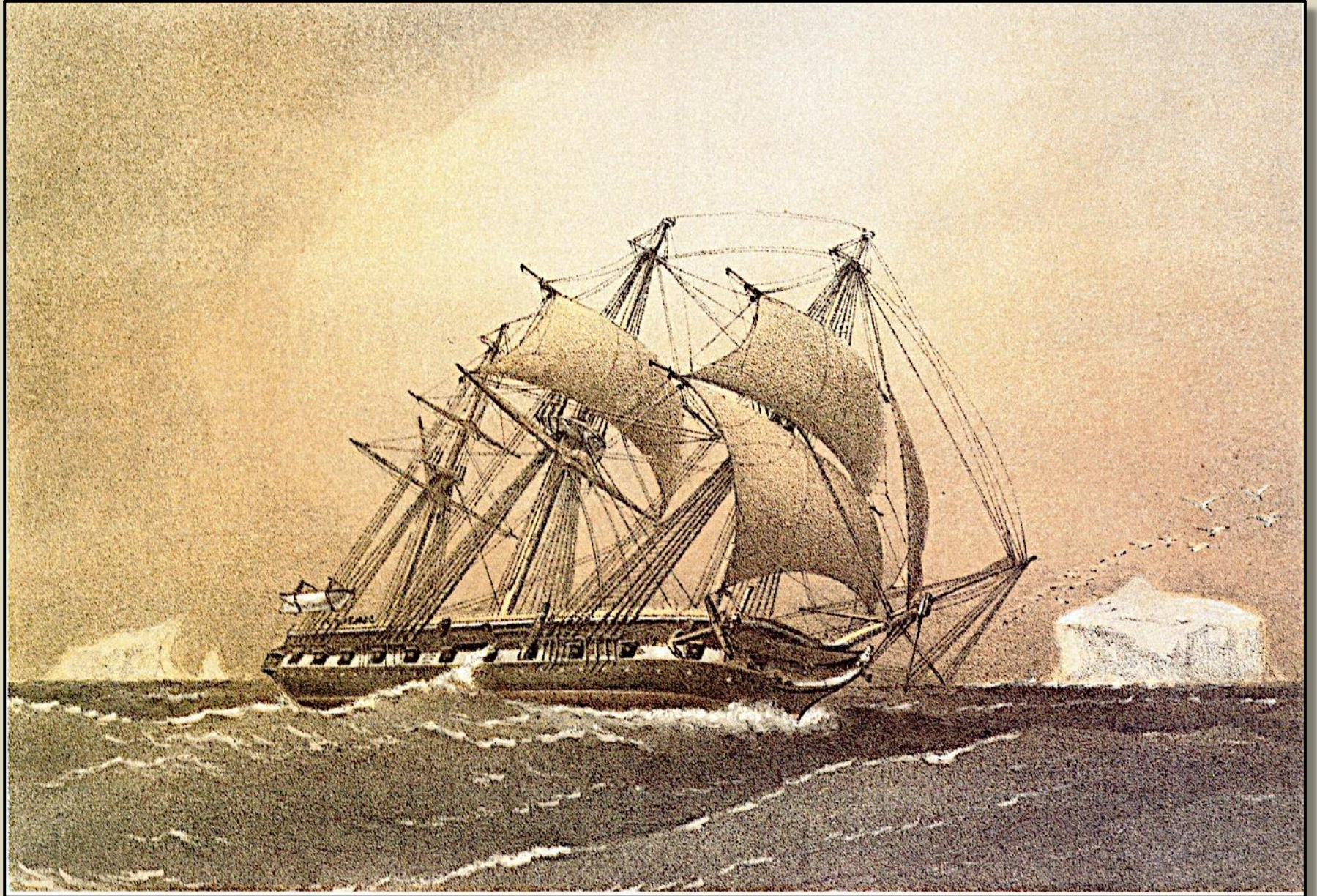
Submarine Cables and the Ocean Environment

Lionel Carter, Victoria University and ICPC

Outline

- ★ **Sargasso Sea - general observations**
- ★ **Natural hazards and cables**
 - earthquakes
 - subsea landslides and turbidity currents
 - deep currents
 - ocean/climate change
 - whales
 - sharks
- ★ **Synopsis**

Subsea cables and science

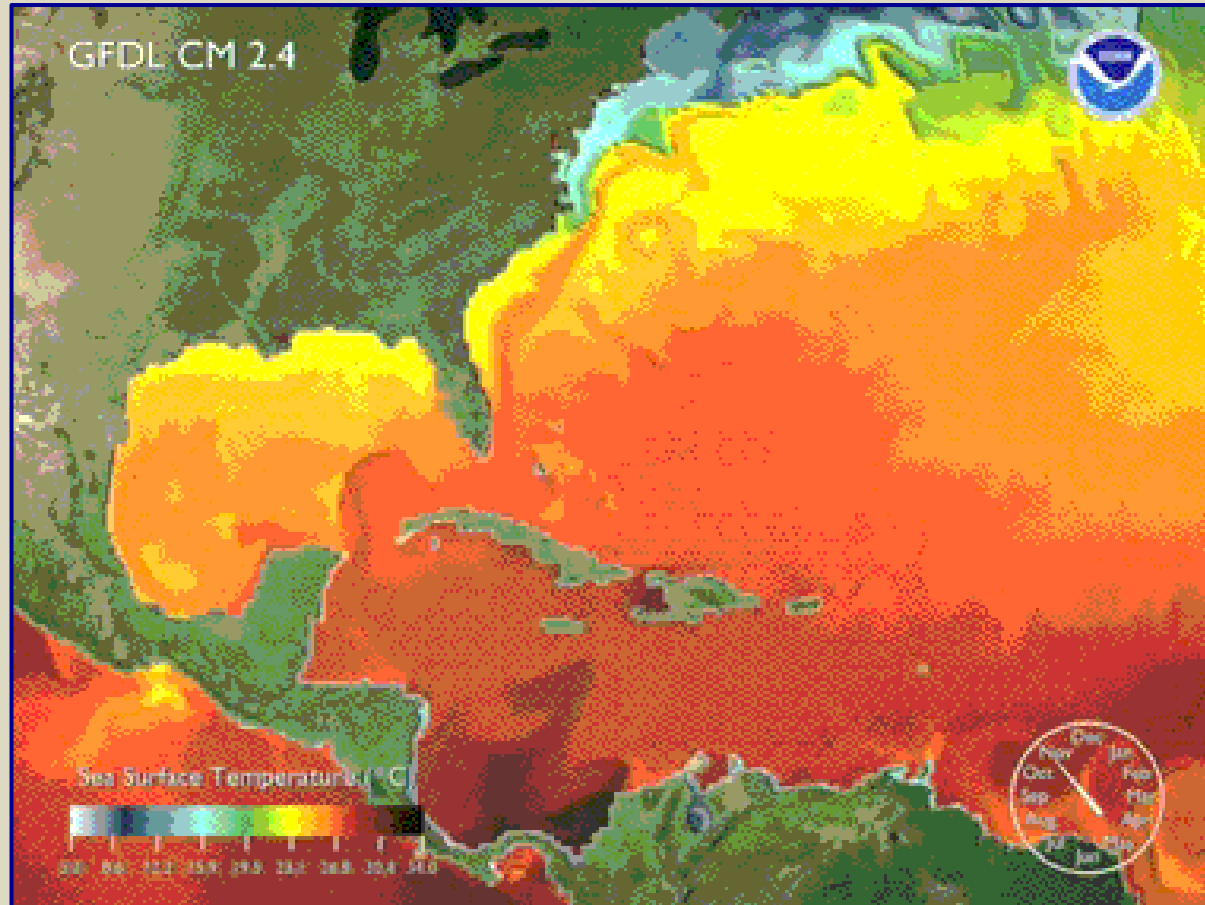


Source: HMS Challenger by W. F. Mitchell.



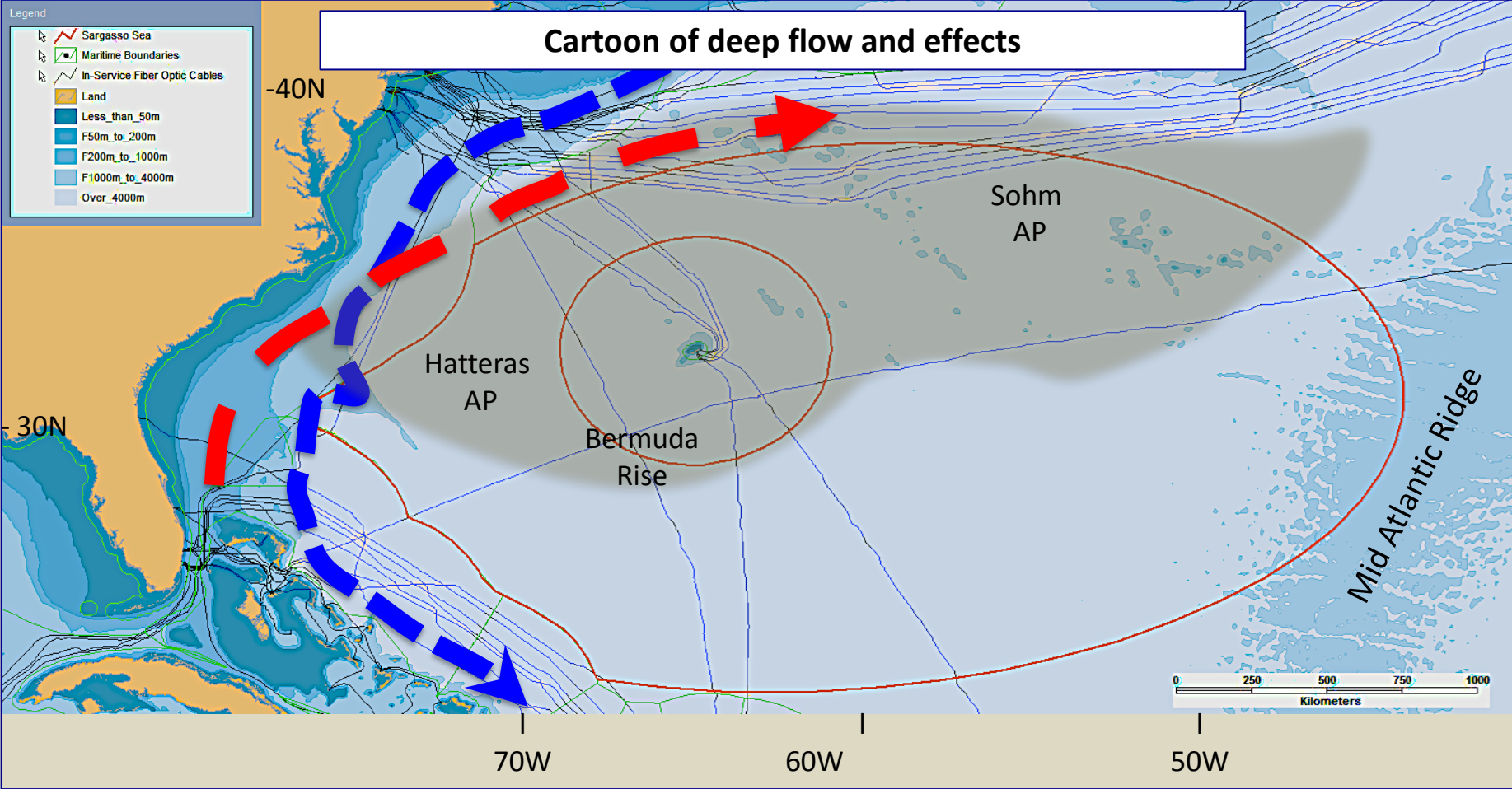
Source: NASA and C. Hadfield.

Sargasso Sea – surface circulation



- ★ Gulf Stream is a large (~ 70 Sv), energetic, eddy-rich flow whose perturbations dominate W to N Sargasso Sea.
- ★ Lesser flows form eastern (Canary Current) and southern (N. Equatorial and Antilles currents) limits of the Sea

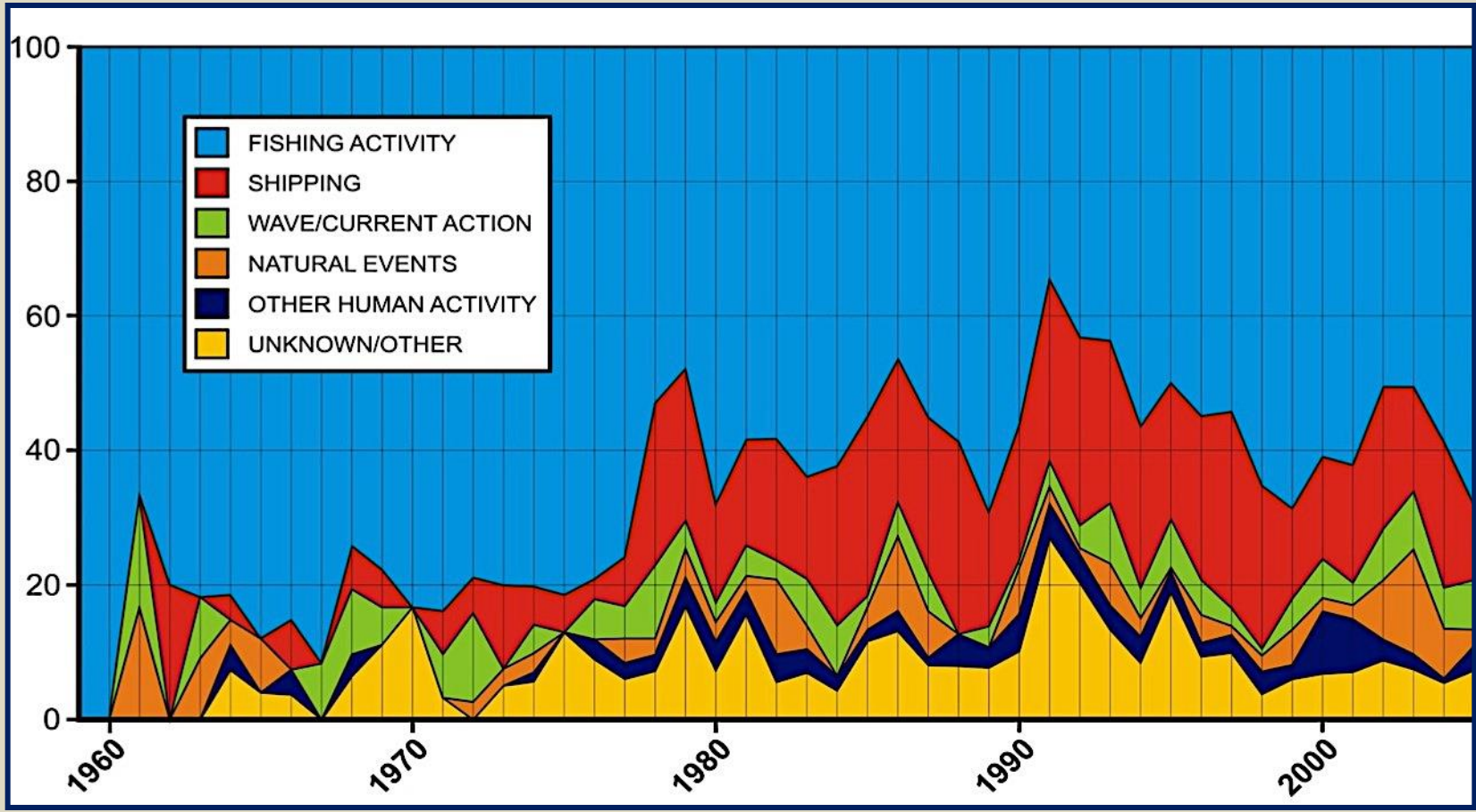
Deep circulation



- ★ Gulf Stream eddies (red) and deep western boundary undercurrent (blue) move sediment. Speeds at 4000m typically 5-10cm/s but rise to >40cm/s in “deep-sea storms”
- ★ Turbulence maintains turbid layer up to 2000m thick (grey).
- ★ Muddy deposits still dominate the Sargasso Sea floor.

Source: McCave Tucholke, 1986; Hall & Bryden 1985;

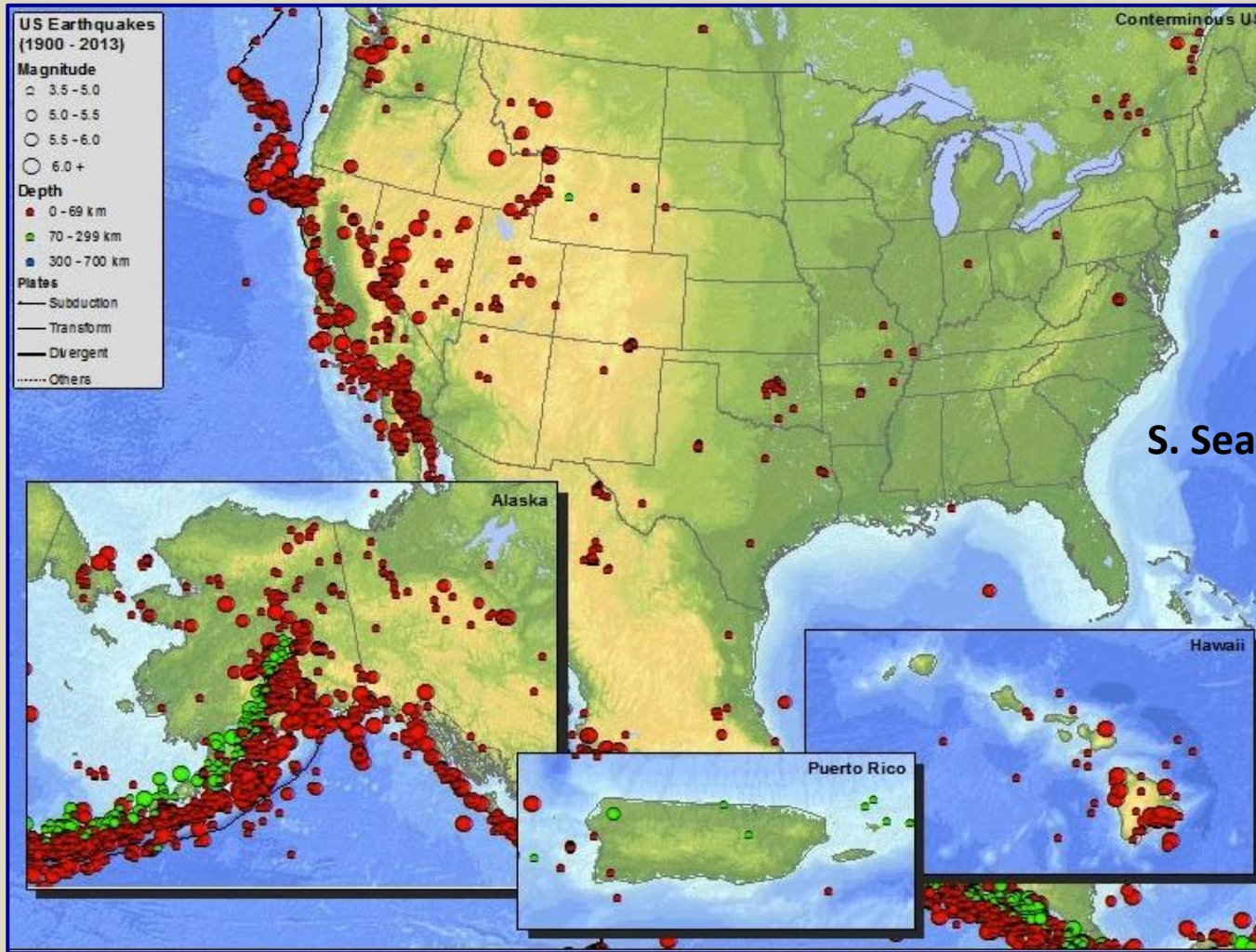
Natural hazards and cables



★ Natural hazards  cause, on average, <10% of all cable faults world-wide

Source: Wood & Carter, 2008; Journal Ocean Engineering.

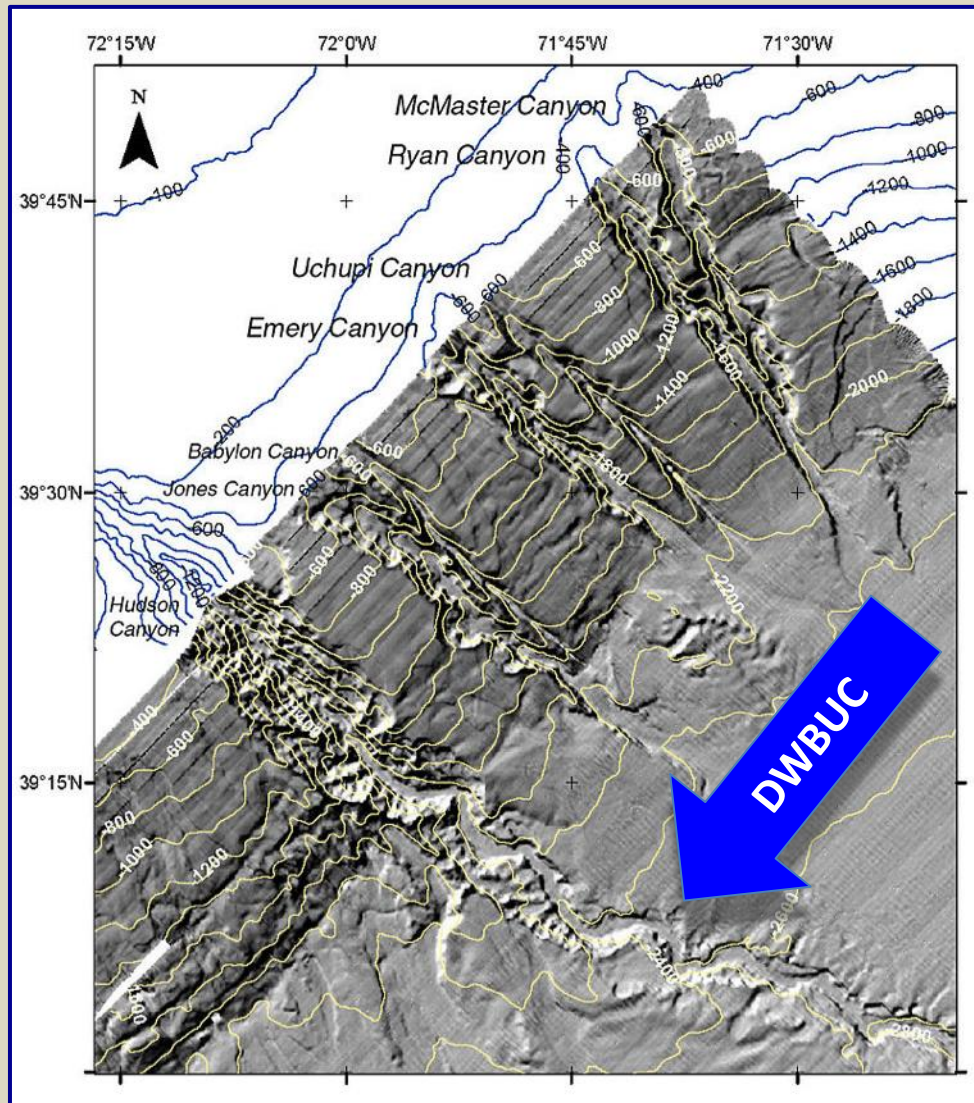
Earthquakes



- ★ Natural hazards prevail off active tectonic plate boundaries.
- ★ Includes floods, subsea landslides, turbidity currents, tsunami.
- ★ S. Sea off passive margin, hence seismic risk low but earthquakes do occur.

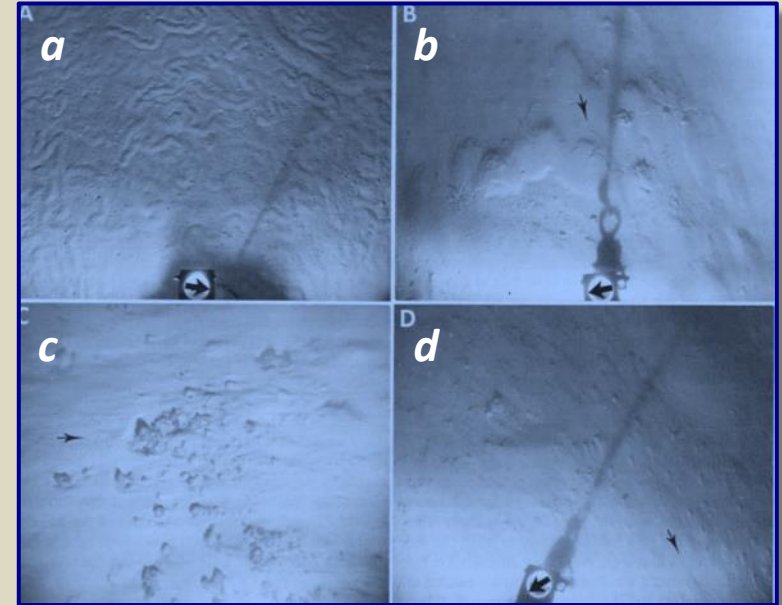
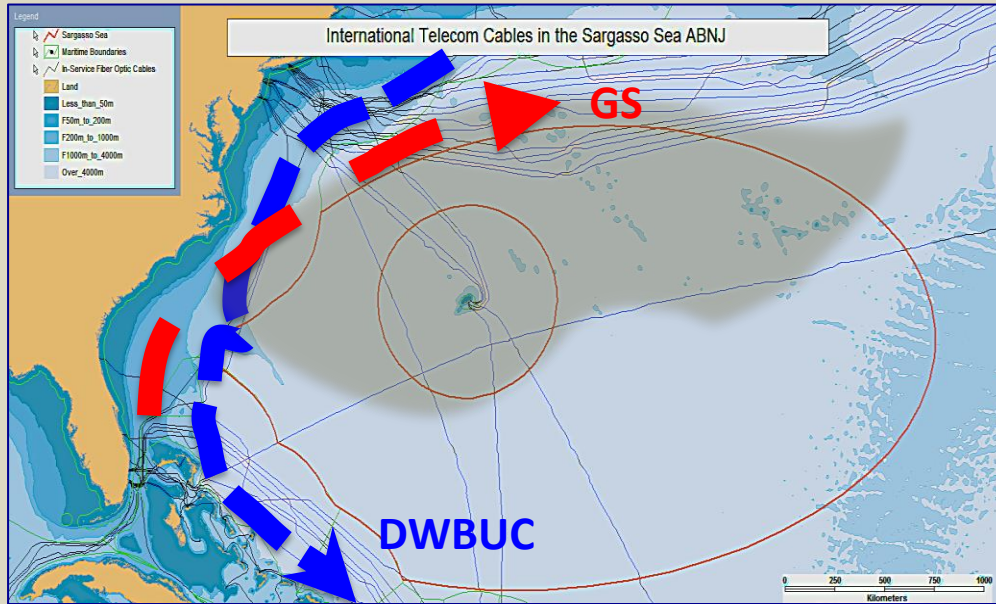
★ US earthquakes for 1900 – 2013 showing aseismic Sargasso Sea

Subsea landslides/turbidity currents



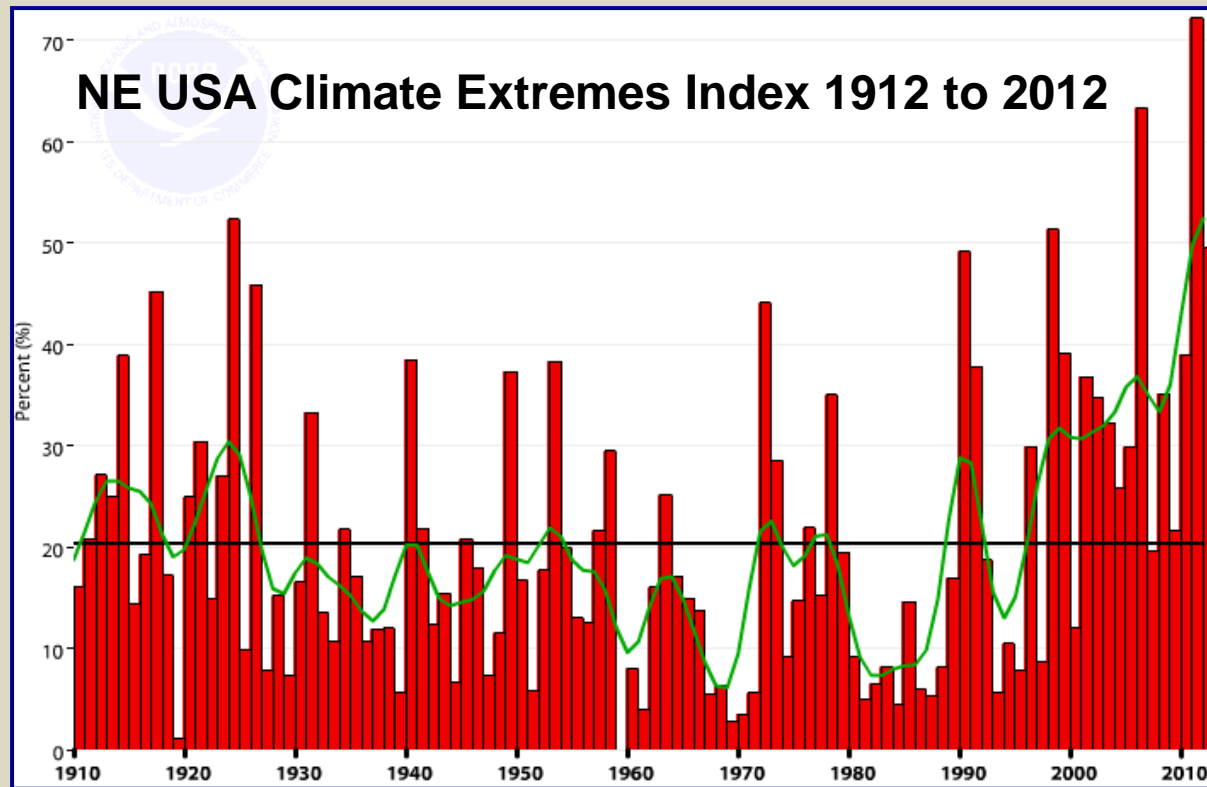
- ★ At high sea level, rivers separated from canyons by continental shelf.
- ★ But large canyons e.g. Wilmington, still guide sediment¹ into deep western boundary undercurrent (DWBUC).
- ★ No modern turbidity current deposits on Hatteras Abyssal Plain² and no cable faults caused by such currents, suggest low risk.
- ★ Contrasts when sea level is low resulting in landslide/turbidity current activity.
- ★ But, infrequent events, e.g. 1929 Grand Banks e'quake, occur.

Deep currents



- ★ **Gulf Stream eddies plus DWBUC form variable benthic regime with erosion and transport especially near western S. Sea margin (e.g., *c,d*) during deep-sea storms when bottom flow speeds may $>40\text{cm/s}$ (0.8knt).**
- ★ **Despite sediment movement, cable faults are few attesting to their resilience.**
- ★ **Within Sea, erosion and transport are reduced (e.g., *a*).**

Climate/ocean change

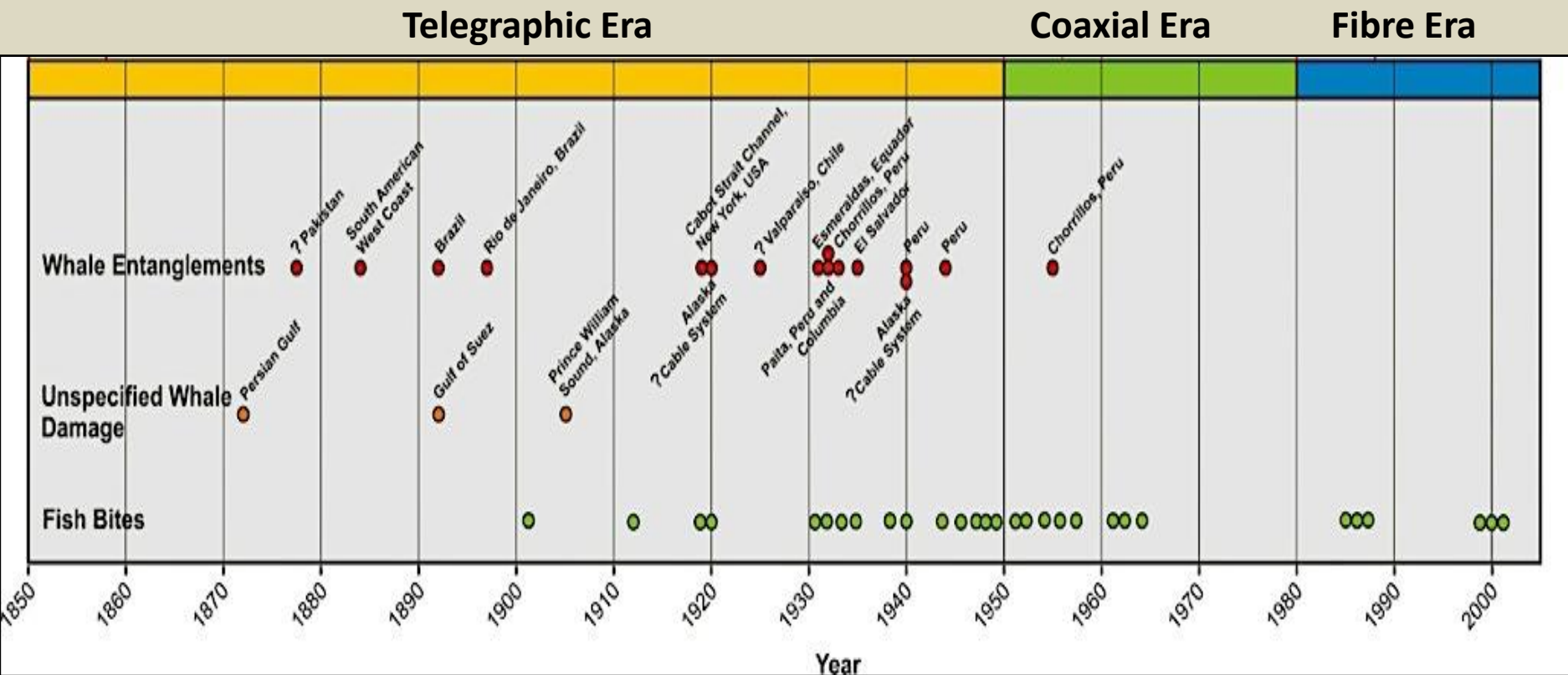


- ★ Gulf Stream warmer and stronger under poleward expansion of subtropical winds – more energetic eddies S. Sea margin?
- ★ Overturning in N. Atlantic and deep-water formation off Antarctica may affect DWBUC – long term change?

Whale entanglements

- ★ Study of 5460 faults revealed 16 entanglements of mainly sperm whales pre-1959.
- ★ Entanglements ceased during transition from telegraph to coaxial cables.
- ★ Transition saw improved cable design and laying that included laying cables under tension, torque balance, better repair techniques to reduce coiling, and burial.
- ★ Apart from local rises, S. Sea depth exceed diving limits of sperm whales.

Fish Bites (including sharks) world-wide



- ★ 1901 – 1957 during telegraph era at least **28** cable-damaging bites.
- ★ 1959 – 2006 when coaxial and later (1988) fibre-optic systems prevailed, **11** cables repaired – 0.5% of all faults
- ★ 2008 – 2013 **no** faults related to fish bites.

Sources: Wood & Carter, 2008; UNEP-ICPC 2009; ICPC Database.

Synopsis I

- ★ ~1 fault per 6 years due to a natural hazard (current abrasion).
- ★ Despite locally energetic deep environment, cables resilient.
- ★ No record of faults due to modern submarine landslides/turbidity currents.
- ★ Response of abyssal ocean to climate change is unclear but likely to be modest and within resilience of cables.
- ★ World wide, faults caused by whales have ceased.
- ★ Faults from fish bites not observed since ~2006.

Synopsis II – evidence-based understanding

Whale Entanglements With Submarine Telecommunication Cables
Matthew Peter Wood and Laurel Carter

Abstract—Between 1960 and 1980, thousands of whale entanglements with submarine telecommunication cables were reported. The entanglements were most prevalent in the North Atlantic and the western Pacific. The entanglements were caused by the cables themselves, and not by the cables' support vessels. The entanglements were caused by the cables themselves, and not by the cables' support vessels. The entanglements were caused by the cables themselves, and not by the cables' support vessels.

I. INTRODUCTION

The entanglement of whales with submarine telecommunication cables was first reported by Huxley (1915). Huxley reported the death of a whale that had become entangled in a cable. The whale was found dead on the beach. The whale was found dead on the beach. The whale was found dead on the beach.

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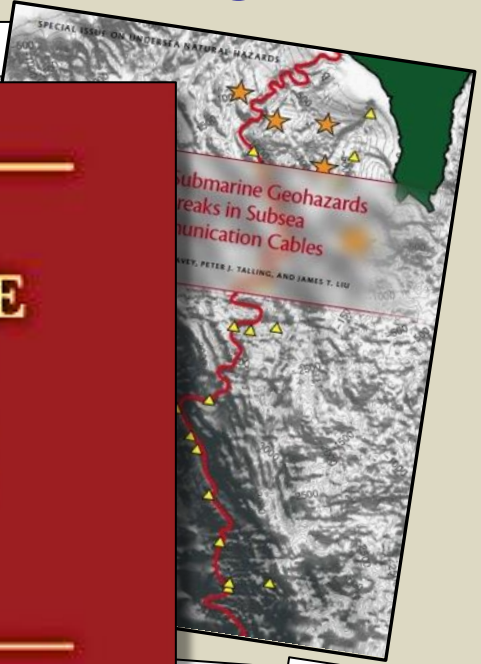
SUBMARINE CABLES

The Handbook of Law and Policy

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connecting the world

Regional Seas

UNEP WCMC

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ATOC/Pioneer Seamount cable after 8 years on the seafloor: Observations, environmental impact

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Abstract

A study was conducted on the impacts of the presence of the Acoustic Thermometry of Ocean Climate (ATOC) Pioneer Seamount cable on the benthos from seamounts near adjacent to its origin at Pinnac Point off the Point Loma in Half Moon Bay, California. In its 8 years on the seafloor, 91 km along its length on Pinnac Point Seamount, the cable was found to be entangled with the benthos. The cable was found to be entangled with the benthos. The cable was found to be entangled with the benthos.

1. Introduction

The ATOC/Pioneer Seamount cable was installed in 1994. The cable was installed in 1994. The cable was installed in 1994. The cable was installed in 1994. The cable was installed in 1994.

Kyungju Technika hospital
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1. This paper is part of a special issue on 'Submarine Cables: Law and Policy' edited by Douglas R. Burnett, Robert C. Beckman, and Tara M. Davenport. The special issue is published in the journal 'Continental Shelf Research'.

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