Near-Surface Processes and Resources

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Here is a Laundry List-
With it, we can prioritize

Major Points in Introduction

- Near-surface is where we live; it is where we interact with the Earth; Societally most important(?)
- Societal relevance of shallow geophysics is increasing as pressures on the environment increase
- Near-surface can be a hostile environment for geophysics (extreme heterogeneity, high attenuation, plane-wave assumptions don't hold)
- Costs of shallow surveys are dropping, allowing for their application in more disciplines

Major Points in Introduction (cont.)

- Need for geophysicists is exploding as near-surface and energy exploration efforts expand
- Need to get shallow geophysical methods into third world countries – need to reduce the costs further
- Seismic cannot be used alone – must use in conjunction with electromagnetic etc. methods
- Much of the near-surface geophysics is termed “applied”; in fact near-surface methods can be used in almost all major studies

Major Scientific Issues

- Understanding the (fresh)water cycle
- Natural hazards prediction, assessment and remediation
- Understanding and monitoring climate change
- Delineating energy and mineral resources
- Time-dependent Effects and Monitoring
- Defense/Security/Forensics
- Archeology
- Technological & Conceptual Frontiers

Understanding the Water Cycle

- Mapping and assessing large aquifers in 3D and 4D (monitoring)
- Characterizing aquifers (velocity=> porosity, permeability)
- Understanding fluid flow within aquifers
- Characterizing and monitoring contaminants within aquifers

3D

Hazards prediction, assessment and remediation

- Imaging shallow faults for paleoseismic/slip analysis, fault zone characterization, time-variant properties (strain?)
- Characterizing geotechnical properties of shallow deposits, including liquefaction and ground failure potential
- Determining the velocity structure/geometry of sites for predicting ground motions
- Characterizing potential ground failure from landslides and karst
- Detecting man-made hazards such as abandoned mines, tunnels, buried landfills, unexploded ordinance (UXO)

Hazards pr

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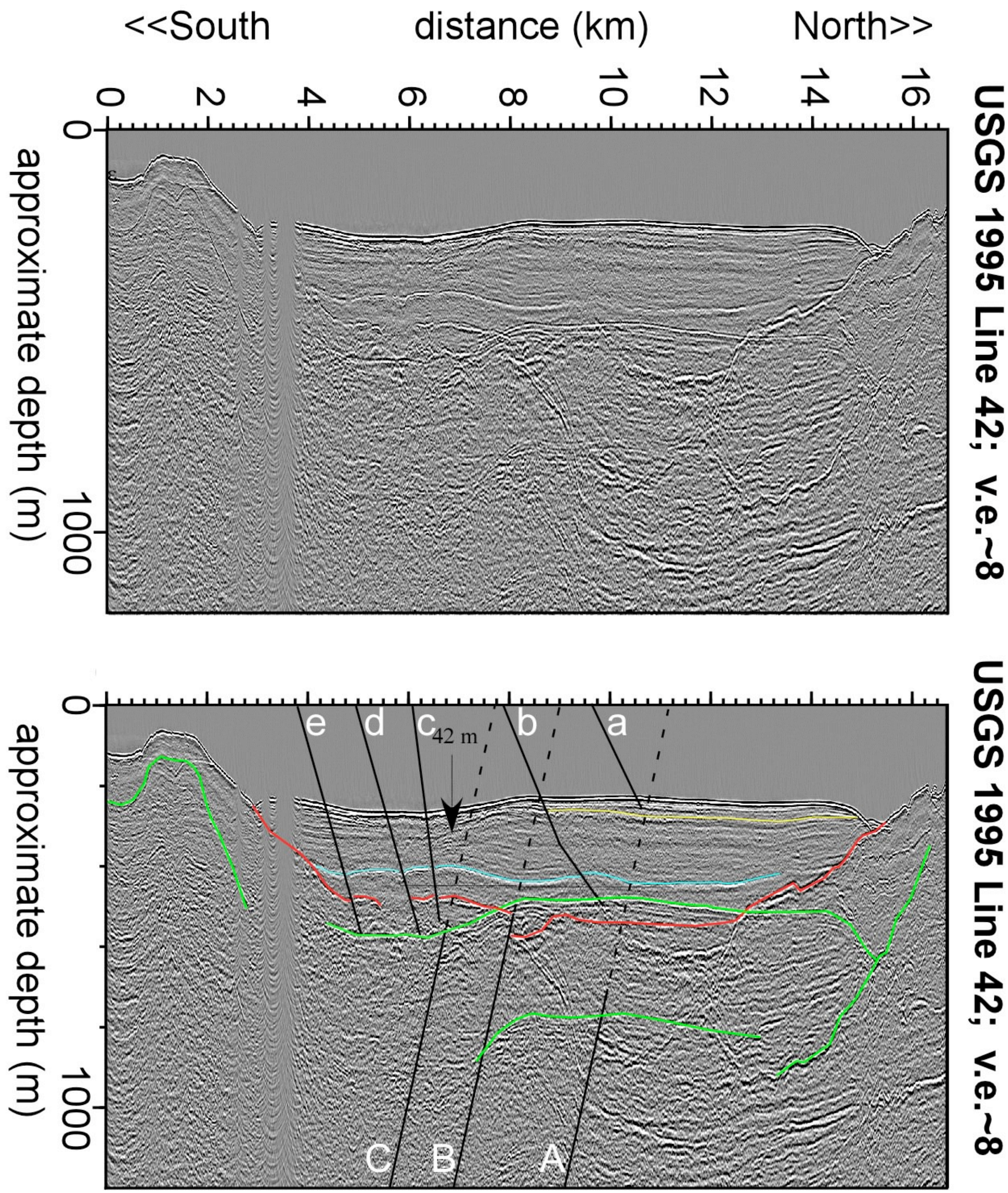
- Detecting mar mines, buried (UXO)



Understanding and monitoring climate change

- Estimating paleoclimate from shallow deposits
- Characterizing and monitoring current climate change (permafrost thickness, changes in gas hydrate)
- Understanding the carbon cycle (mapping gas hydrates, accumulation of carbon in seafloor sediments, carbon sequestration)
- Aiding other climate studies such as coring

Delineating energy and mineral resources

- Mapping the volume of gas hydrates, and assessing their hydrate content
- Assessing geothermal resources, both obvious (Iceland) and less obvious (potential heat storage beneath buildings)
- Exploring and mapping energy and mineral deposits such as coal seams and ore bodies

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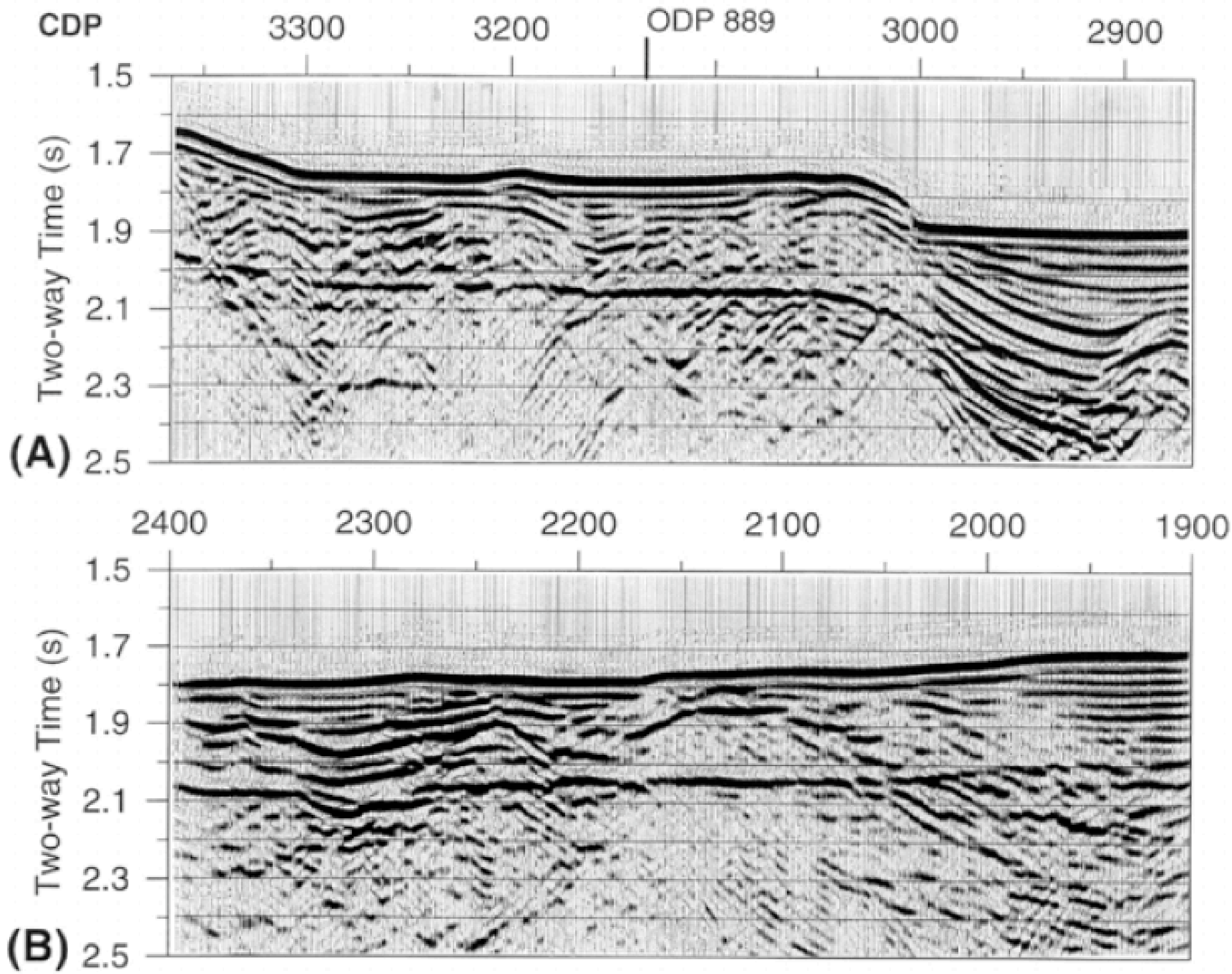

Fig. 3: Regional conventional (low frequency) MC seismic data showing strong BSR.

Time-dependent Effects and Monitoring at Multiple Time Scales

- Non-linear soil response, expansive soils, groundwater recharge over wide areas
- 4D monitoring of fluid levels and flow; seasonal variations
- Changes in fault-zone properties over earthquake cycles
- Response of Earth to loading or unloading by reservoirs, buildings, quarries, tides, storms

Defense/Security/forensics

- Forensics – locating blasts, explosions, impacts, industrial accidents
- Security monitoring for tunneling, trespassing, underground activity, troop movements
- Finding underground munitions, facilities, bunkers, tanks
- Search and rescue (avalanche, mudslide, trapped miners, cavers, building collapse)

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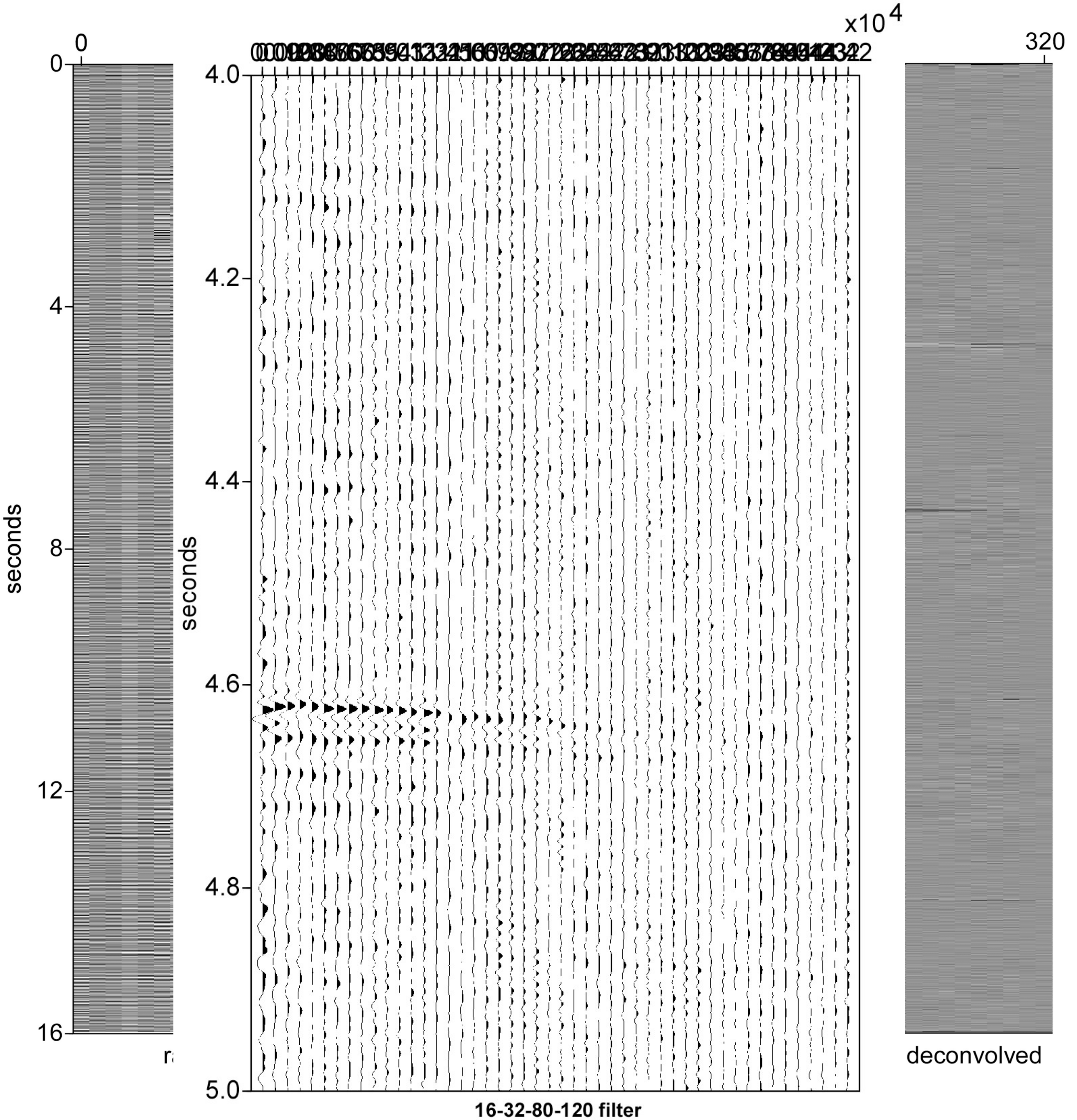

Archeology

- 3D mapping of archeological sites
- Characterizing buried objects/chambers

Technological & Conceptual Innovation

- Development of passive imaging methods using ambient noise
- Characterizing properties of subsurface materials (interdisciplinary studies)
- Rapid, cheap 3D and 4D imaging over large areas
- 0-mass, 0-cost, inf-band recycled-paper sensor (millions of these!)
- Non-contact imaging (InSAR, LiDAR)
- Making technology affordable for geophysicists in developing countries (cell-phone seismograph?)

Hammer taps: music and geode recording system comparison; raw (unfiltered) data