Please find attached a list of review questions.

Think at them as

"what is/are...."

"how it works...."

"what is the basic physical principle...."

"what are the main applications...."

"which method is best suited for ....."

Regards

Giancarlo Bernasconi

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**Elastic media and elastic waves**

**- homogeneous/non homogeneous, isotropic/anisotropic medium**

Homogeneous [ˌhɒməˈdʒiːniəs]: properties (e.g., density, elasticity) are the same everywhere. Example: Pure quartz.

Non-homogeneous [ˌnɒn həʊməˈdʒiːniəs]: properties change with position. Example: Sedimentary rock layers with different compositions.

Isotropic [aɪˈsɒtrəpɪk]: properties are the same in all directions. Waves travel at the

same speed regardless of direction.

Anisotropic [ˌænɪˈsɒtrəpɪk]: properties depend on direction (e.g., layered or crystalline rocks). where wave velocity depends on the direction of propagation.

- P- and S-waves: velocity and polarization

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P-waves: ongitudinal

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Transverse or shear waves.

**- surface waves**

Travel **along the surface**; amplitude **decays with depth.**

**Two main types**:

Rayleigh [ˈreɪli] waves: elliptical motion (vertical + horizontal).

Love waves: horizontal shear motion; often largest amplitudes, slower than body waves.

**Applications:**

Used in seismic surveys and telecommunications for surface-based signal

propagation studies.

**- acoustic media**

**A medium in which pressure waves (P-waves) can propagate.**

In fluids (liquids, gases) only compressional (P) waves propagate; no shear.

In solids, P and S waves both exist (elastic medium).

**Applications:**

Used in ultrasound, underwater acoustics, and telecommunications applications like

SONAR and ultrasonic transducers.

**- interface between 2 media: scatter coefficients,**

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**- wave amplitude attenuation. What causes wave amplitude attenuation?**

Geometric spreading: energy spreads with distance

Intrinsic absorption: Energy is lost as heat due to the internal friction of the medium (quantified by the quality factor Q).

Scattering: Part of the wave energy is deflected in different directions when encountering

irregularities.

**- measured variables, output display**

Measured variables:

• Wave velocity, amplitude, frequency, phase, travel time.

• Output formats:

Seismic traces, wavefield snapshots, spectrum analysis graphs.

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**Electrical methods √**

**- principles**

**Electrical methods — principles**

We inject current into the ground and measure a voltage at the surface.

Using Ohm’s law, we compute apparent resistivity ρₐ = K·ΔV/I (K = geometric factor of the array). (Ohm’s Law: 𝐽 = 𝜎𝐸 where J is the current density, 𝜎 is conductivity, and E is the electric field.)

Current prefers low-resistivity paths; high-resistivity bodies deflect current.

The data are sensitive near the surface and less sensitive at depth (trapezoid coverage).

**- equipment**

Current electrodes (A, B), potential electrodes (M, N).

A resistivity meter (current source + voltmeter), electrode cables and switcher, GPS/measure tape.

In the homework: RES2DMOD (forward modeling) and RES2DINV (inversion) to simulate and invert data.

**- how to build a pseudosection**

•A pseudosection is a 2D representation of apparent resistivity.

**Steps:**

• Collect resistivity measurements using different electrode spacings.

• Arrange data in a depth plot, assuming greater depth for larger electrode spacing.

**- apparent and true resistivity**

Apparent resistivity (ρₐ) = what we compute directly from field data; it is an averaged response, not the true subsurface. a homogeneous medium.

True/model resistivity (ρ) = what we estimate by inversion (RES2DINV) from all the data, with regularization to stabilize the solution.

They use the same unit (Ω·m) but mean different things; do not compare values one-to-one.

**- measured variables, output display**

Measured: injected current (I) and voltage difference (ΔV).

Derived: apparent resistivity ρₐ, RMS misfit between measured and calculated data.

Displays (homework):

Measured pseudosection (observed ρₐ).

Calculated pseudosection (predicted ρₐ from the current model).

Inverse model resistivity section (estimated “true” ρ).

Sensitivity map (where data constrain the model best).

Keep the same color scale when comparing models; report RMS (%) to show data fit.

We inject current, measure voltage, compute ρₐ = KΔV/I, plot a pseudosection, and invert the data to get a resistivity model; ρₐ is data, ρ is the inverted model, both in Ω·m, and we judge quality with RMS and the sensitivity map.

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**Electromagnetic methods √**

- EM parameters

- low and high frequency measurements

- applications

- equipment (ground conductivity meter, metal detector)

- measured variables, output display

**1. What are EM parameters?**

• **Electrical conductivity (**𝝈**)**: Ability to conduct electricity. 电导率

• **Magnetic permeability (**𝜇**)**: Response to a magnetic field. 磁导率

• **Dielectric permittivity (**𝜺**)**: Response to an electric field. 介电率

**2. What are low and high-frequency measurements?**

• **Low frequency (e.g., magnetotellurics, VLF methods)**: Penetrates deeper.

• **High frequency (e.g., Ground Conductivity Meters, GPR)**: Limited penetration, higher

resolution.

**3. What are the applications?**

• Used in geophysical exploration, detecting underground utilities, and environmental assessments.

**4. What equipment is used?**

• **Ground conductivity meter**: Measures conductivity to map subsurface variations.

• **Metal detector**: Finds buried metallic objects based on induced eddy currents.

**5. What are the measured variables and output display?**

• **Variables**: Magnetic field strength, phase shift, conductivity.

• **Output**: Conductivity-depth profiles, subsurface maps.

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**-GPR √**

- principles

- applications

- link between antenna central frequency, penetration depth, resolution

- measured variables, output display

**1. What are the principles?**

• GPR transmits high-frequency electromagnetic waves into the ground.

• Reflections occur at material boundaries with different dielectric permittivity.

**2. What are the applications?**

• Used for utility detection, archaeological surveys, structural assessment, and environmental studies.

**3. What is the link between antenna frequency, penetration depth, and resolution?**

• Higher frequency:

Better resolution, but lower penetration.

Used for detecting shallow objects (e.g., cables, concrete assessment).

• Lower frequency:

Greater penetration, but lower resolution.

Used for deeper targets (e.g., groundwater, void detection).

**4. What are the measured variables and output display?**

• Variables: Reflection amplitude, two-way travel time, depth.

• Output: Radargrams (amplitude vs. travel time), depth slices, 3D subsurface models.