

# SEISMIC REFRACTION ANALYSIS OF LANDSLIDES

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**GEO 480: Special Topics**

Done for Dr. Ali Oncel

By

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## OUTLINE

- INTRODUCTION
- BACKGROUND
- PURPOSE OF THE ARTICLE
- THE TREE EXAMPLES OF PROCESSING "Just 2 of them will be explained"
- CONCLUSION

## INTRODUCTION

- Seismic refraction is a technique that has been used to investigate landslides since the early 1960's.
- Refraction surveys in landslide investigations Vs. other methods
  - environment is not disturbed,
  - the equipment is portable,
  - and the technique is relatively inexpensive
- One limitation of seismic refraction is the inability to discern the existence of certain beds or layers;  
"hidden layers"
- Another limitation of seismic refraction are incorrect depth calculations to certain layers where velocity reversals exist, i.e., where layer velocities do not increase with progressive depth.

## BACKGROUND

How to get benefit from the seismic refraction data of the landslides?

>>Cont.

## BACKGROUND

- There is two method of interpretation:
  - **Generalized Reciprocal Method "GRM"**
  - **Intercept-Time Method (ITM)**
- The **Refraction Tomography** is another method of interpreting seismic refraction data.

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## BACKGROUND

### Generalized Reciprocal Method "GRM"

- **GRM** calculates refractor depths for each geophone location using overlapping refraction arrival times from both forward and reverse shots.
- To apply GMR, two assumptions should be assumed:
  - ✓ A layered model.
  - ✓ Continuity of refractor surfaces across a profile.
- For most effective GRM, we should have:
  - ✓ Simple velocity structure.
  - ✓ Gentle Dipping of  $< 20^\circ$
- The GRM depends on the data of the forward and reverse shots, and on the selection of an optimum XY value.

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## BACKGROUND

### Generalized Reciprocal Method "GRM"

- XY = the distance of separation measured at the surface where forward and reverse seismic waves originate from the same point on the refractor.
- Two types of the GRM analysis can be used:
  - ✓ The approximate velocity (**AP**) and
  - ✓ The average velocity (**AV**) methods.
- The approximate velocity method is
  - ✓ relatively insensitive to optimum XY selection.
  - Does require that every refractor above the target be defined.
- In contrast, the average velocity method is
  - ✓ very sensitive to optimum XY selection.
  - ✓ does not require that every refractor above the target be known

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## BACKGROUND

### Intercept-Time Method "GRM"

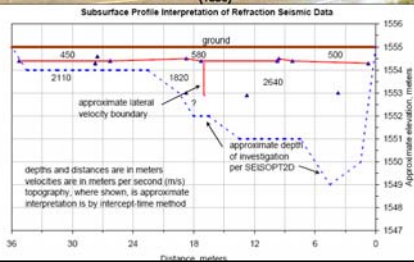
- Interpretation by ITM assumes that the subsurface material layers or zones are present, and that each layer has a uniform velocity.

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Figure 2. Example ITM interpretation with apparent depth of investigation from optimization interpretation. Upper photo shows exposed limestone at the proposed excavation cut. The center plot shows the ITM and depth of investigation interpretation. The lower plot shows the time-distance plots for the seismic first arrival data. Project units are metric, and seismic wave velocities are in meters per second (m/s).



Michael L. Rucker, 2002



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## BACKGROUND

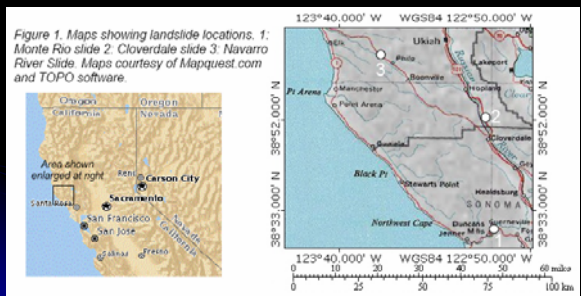
### Refraction Tomography

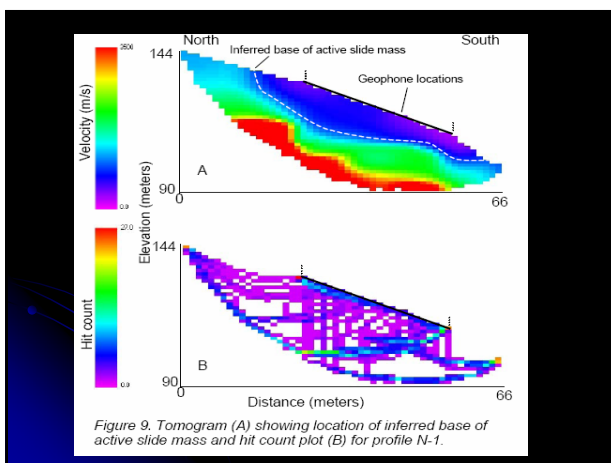
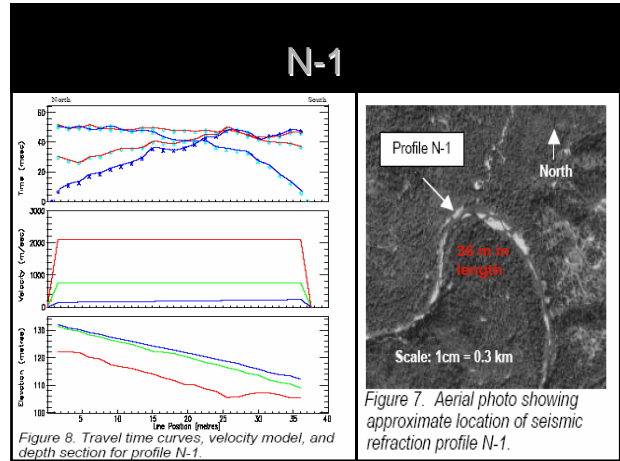
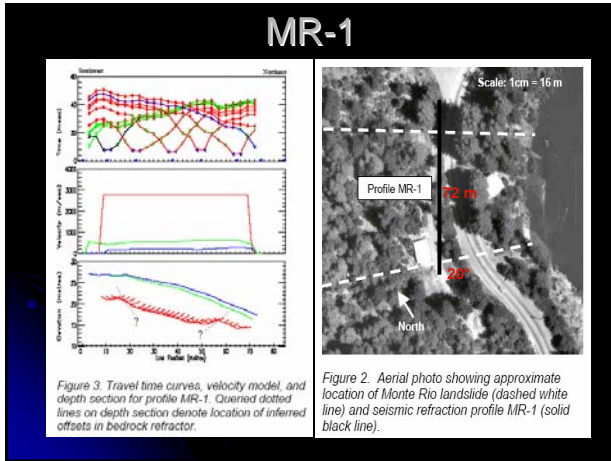
- If the assumption of the GRM which assume continuity of refractor surfaces across a profile, is not valid, then the refraction tomography can provide better results.
- Tomography is a technique where measurements are made of energy that has propagated through a medium. The received character of the energy is then used to infer the properties of the medium through which it propagated.

## PURPOSE OF THE ARTICLE

- To understand and characterized the landslides in the **Coast Ranges of northern California, CA**, which receives a high amount of rainfall and is exposed to landslide activity.

## MAP SHOWING LANDSLIDE LOCATIONS





## CONCLUSION

- In the **Monte Rio** profile, the apparent vertical displacements in the bedrock refractor may indicate the landslide is a deep-seated feature.
- The velocity distribution of a landslide along the **Navarro River** can be explained by a rotational slide superimposed on a larger landslide with fracturing and displacement extending into bedrock.
- Seismic refraction surveys and analyses of the data aided in characterizing the landslides