Second draft array course outline
Using Ambient Vibration Array Techniques for Site Characterization
Monday, 21st Nov. 2005 to 25th Nov. 2005

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1 Course outline

	Monday
13:30	Reception and welcome
	Technical issues and program overview
14:00-14:45	Introduction
	Overview of the physical background of ambient vibration studies. The Presentation covers the basic assumptions about the ambient vibration wave field, the linkage between subsurface structure, wave field propagation properties, the use of ambient vibration array analysis for observation and recovery of site characteristics (site response).
14:45-15:00	Coffee break
15:00-17:15	Basic array processing concepts
	In this lecture the basic array processing concept is presented from the viewpoint of general multi-channel filter operations. As underlying operation, the shift-and-sum technique in time domain is used as point of departure before transferring the problem into the frequency wavenumber (f–k) domain.

	Tuesday
9:00-10:30	Array Geometry and Response
	The discrete spatial sampling of the continuous seismic wave field by small groups of seismic stations (arrays) has severe consequences regarding the resolution and the uniqueness of propagation characteristics which are estimated from array data records. This lecture aims to demonstrate these effects for simple linear array layouts as well as 2D-array settings and outlines the relation between array geometry and resulting estimation capabilities. As key concept for estimating the capability of an array layout, the array response function is introduced.
10:30-10:45	Coffee break
10:45-12:15	Array Geometry and Response – Practical
	The practical will allow the participants to apply the acquired knowledge about array geometries and to evolve a feeling how a change in array layout is reflected in the corresponding array response. A software tool which facilitates these tasks is presented and its handling will be explained in detail.
12:15-14:00	Lunch break
14:00-15:30	GEOPSY - round trip and first steps
	The core software module of the SESARRAY software package, named GEOPSY, will be presented. The participants will be trained in a step by step tutorial to create data bases and to use the standard tools for data visualization, manipulation and standard signal processing.
15:30-15:45	Coffee break
15:45-17:15	Conventional f–k - Practical
	Based on the data base example created in the previous practical, the standard f–k algorithm will be applied to estimate dispersion curves. The discussion of the analysis results will give new insight into dependencies between the observability of dispersion curves, array geometries and the subsurface structure.

	Wednesday
9:00-10:30	Capon's Method – high resolution f–k
	This lecture introduces the background of a widely used method in the realm of ambient vibration array analysis: the high resolution f–k method after Capon (1969). After method presentation, participants will apply the method to the introduced data sets for deriving dispersion curves. The results are to be compared with the standard f–k method.
10:30-10:45	Coffee break
10:45-12:15	SPAC Method
	The spatial autocorrelation technique (SPAC) was introduced by Aki (1957) and is probably the most widely used method for ambient vibration array analysis worldwide. The background of the method is introduced and its differences to the f–k techniques are outlined. Newer developments in recent times are based on Aki's original work and will be presented in this lecture. After the method's introduction, participants will apply the method to the data sets and a direct comparison with f–k results will be discussed.
12:15-14:00	Lunch break
14:00-15:30	Dispersion curve inversion
	Within this lecture, the fundamentals of inversion theory are introduced making use of the problem at hand - the inversion of dispersion curve data. The lecture introduces the forward problem, the concept of parameter space, data space, misfit functions and, for the non-linear problem to be solved, the non-uniqueness problem. For the solution to non-linear inversion problems, direct search methods will be reviewed with a special focus on the Neighborhood Algorithm (Sambridge 1999) being the core of the inversion software program package.
15:30-15:45	Coffee break
15:45-17:15	Inversion - Practical (first steps)
	A step by step procedure will be applied to a theoretical dispersion curve in order to identify critical issues in the inversion task. In particular the effects of 1D initial model parameterization and parameter (v_P, v_S, ρ, ...) range restrictions on the final outcome of the inversion will be demonstrated and discussed.
20:00-	Workshop Dinner

	Thursday
9:00-10:30	Inversion - Practical (Advanced)
	The course attendees will be guided to invert the analysis results which have been obtained from f–k (standard and high-resolution) and SPAC computations the day before. A combined interpretation of analysis results is necessary and enter into the decision on the usable frequency range for the inversion target (estimated dispersion curve).
10:30-10:45	Coffee break
10:45-12:15	Discussion of inversion results
	The inversion results obtained by the course participants will be compared with the true underlying model. The cause of apparent discrepancies between obtained inversion results and the true model, as well as the variability of results will be discussed.
12:15-14:00	Lunch break
14:00-15:30	Analysis and inversion of test data sets I
	In this practical, a blind test experiment will be performed among the course attendees. For a synthetically modeled ambient vibration wave field, participants choose their own array layouts, analyze the selected records with f–k methods and SPAC technique and finally derive the underlying velocity model.
15:30-15:45	Coffee break
15:45-17:15	Analysis and inversion of test data sets II
	Continuation of the previous practical. Now a real data set will be investigated with the goal to derive the site characteristics.

	Friday
9:00-10:30	Discussion of results from data sets
	In a short presentation of 5 minutes, participants have the opportunity to present their results for both synthetic and real data examples. the results shall be discussed among the group and an interpretation of the results for both cases shall be given.
10:30-10:45	Coffee break
10:45-12:15	Summary of SESAME findings
	The final course lecture summarizes the various steps involved for the task of ambient vibration array analysis and site characterization by the inversion of 1D earth models. Important findings from the SESAME project as well as open questions in this field will be discussed.
12:15-14:00	Lunch break
14:00-	Departure of Participants / Open discussion