Valerio Poggi

☞ Web: http://seismo.org/ValerioPoggi

✉ E-mail: poggi.valerio@gmail.com

☏ Phone: (+39) 339 59 94 678

Research Statement

Overview

My main research interests are in the field of **applied** and **engineering seismology**. In particular, I am presently focusing on the development and direct implementation of new geophysical techniques for local site characterization and novel approaches for seismic response analysis and ground motion prediction. This is done at very different scales, from seismic hazard assessment (probabilistic and deterministic) to microzonation. My priority is to decrease the level of uncertainty in the prediction of the surface ground motion, which can be obtained by means of an increased resolution on the subsoil structure (at regional to local scale) and with a better understanding of sites' geophysical properties.

My primary expertise is in the fields of **seismic wave-propagation and signal processing**, with application to **ambient vibration seismology** and the analysis of **diffuse wave-fields**. **Numerical modeling** is also within my interests, as I am presently focusing on the simulation of the ambient-vibration wave-field for the validation of newly developed geophysical tools.

For the future I aim to develop an **internationally renowned research group** that focuses on the issues of geophysical site investigation and wave-propagation in the upper crust, while **improving the interface between engineering seismology and classical geophysics**. The concepts of wave propagation extend to numerous fields in seismology due to the complex interaction of source, path and site-effects. I will consider the significant role of the upper crustal structure in seismic wave amplification and attenuation which tends to mask the effect of source and path effects. This will therefore lead to better resolution and understanding of earthquake source parameters, such as radiated energy and magnitude.

In the wider context, I will use my research to improve seismic hazard and risk analyses, facilitating the mitigation of **damage due to earthquakes** and reducing uncertainty.

Research Outlook

My future research is oriented to the development and implementation of innovative, physically-based strategies for **ground motion prediction, site characterization and local site response evaluation**, with particular focus on practical aspects that are essential for engineering seismology.

To improve the reliability of ground motion models, I consider it necessary to focus on parameters that are relevant - but too often underestimated - on the modification of the ground motion at high frequencies (roughly > 5Hz), such as the **intrinsic attenuation and scattering**. Large uncertainties in GMPEs are often related to the use of oversimplified models to describe path and site attenuation. Frequently, homogeneous (average) Q models and one-dimensional structures are assumed. Using such an approximation is advantageous, as it significantly reduces the complexity of ground motion models, but has the drawback of leading to non-negligible prediction errors, especially in tectonically complex regions. Practical assessment of intrinsic attenuation is however a controversial issue, primary due to the difficulty in isolating the attenuation information from the recordings. Typically, indirect methods are used to estimate Q in the upper crust, such as empirical relations with seismic velocities; a sufficient accuracy has not been yet reached by direct measurement. One challenge is therefore to develop **new direct methods to quantify attenuation in complex-media**.

Popular approaches to map the three-dimensional variability of velocity and attenuation over large areas are based on spectral fitting of body waves (mainly P phases). Techniques such as **surface-wave tomography** represent a useful alternative. Surface waves are the result of multiple reverberation of the wave-field in the medium and have therefore longer duration and amplitude than body waves. Furthermore, surface waves of different periods have different sensitivity to depth, which allows a top-down approach to constrain and resolve structural properties. Besides traditional surface wave attenuation tomography methods, the use of **ambient vibration tomography** is a relatively novel approach, but rapidly developing within the seismological community. The main benefit of such an approach is in that it can easily be applied in low seismicity regions, as no earthquake events are necessary for the processing. Moreover, the combined use of Rayleigh and Love phases makes possible to constrain P- and S- wave attenuation at the same time. Ambient-vibration surface-wave tomography has been successfully applied on global scale problems, but its application on regional-to-local scales still represents an open field of investigation. My goal is to go beyond the standard existing approaches - nowadays mostly based on waveform cross-correlation stacking - by introducing **new techniques based on wave-propagation concepts**, such as waveform decomposition and full spectral inversion.

My future interests are also in the **numerical modeling of the diffuse wave-fields**, with the ambition to reach a better understanding of the nature and composition of natural ambient-vibrations, and to develop new strategies of analysis for passive imaging and seismic monitoring. These research topics, other than of pure academic interests, might also be appealing for the private sector - such as geothermal exploration - with whom I am willing to establish new collaborations.

Ongoing Research

Among different research interests, I am currently investigating the possibilities of the so-called **quarter-wavelength parameters** (average velocity and seismic impedance contrast) to predict the variation of the ground motion at the surface due to local site conditions. From those, a new generation of proxies for seismic hazard analysis and ground motion prediction equations is under development. As an example, a predictive model to compute **vertical-to-horizontal ratio of 5% damped response spectra** was recently finalized using such approach. Two different models were calibrated for both the Japanese (KiKNet) and the Swiss network. Similarly, I explored the influence of different soil conditions on the anelastic part of the earthquake spectrum. I carried this study by analyzing the variability of **attenuation** (*kappa* term, obtained from direct spectral modeling of low-magnitude earthquakes) at stiff-soils and rock sites. From that, a **predictive attenuation model** was then proposed, which is purely based on quarter-wavelength concepts. In close connection with that, a procedure to predict the **full seismic anelastic amplification spectrum** at soft sediment sites is being finalized; the resulting amplification model will be integrated into next generation site-specific seismic hazard of Switzerland.

Regarding the development and implementation of new techniques for site characterization, I am presently exploring capabilities and limitations of **mixed active-passive seismic surveys**, to extend the resolution of the P/S-wave velocity ground profiles at large depth, while reducing the uncertainties in the local seismic response at high frequencies. The combined use of controlled sources and natural ambient-vibration has the clear advantage to compensate for the relative lack of energy and coherency in the complementary frequency bands, giving more resolution on details of the soil structure at different scales. In addition to that, my present research focuses on the development of better strategies for **join inversion of multiple datasets**, including multi-mode and multi-component surface-wave dispersion and polarization curves, seismic refraction and VSP data and empirical amplification functions. I am particularly interested in understanding and **correct handling the propagation of uncertainties** to the final model, for which a Bayesian approach is best suited.

Teaching Goals

My teaching interests are primary in - but not limited to - the fields of **signal processing**, **applied and engineering seismology**, **inverse theory** and **seismic wave propagation**. I am nevertheless motivated to extend my teaching experience to other complementary fields of geophysics and geology, according to the needs of the department.

My previous teaching experiences are with the *Engineering Seismology Course* of ETH, the *Laboratory Course of Applied Geophysics* and the ETH *Post-Graduated Program for Practitioners* (ETH Certificate of Advanced Studies). I expect to build up a teaching program that strikes the right balance between theory and practice, involving students in the direct handling and basic processing of geophysical/seismological data.

The analysis of ambient vibrations, being a sufficiently mature and independent branch of seismology and geophysics, can constitute a dedicated course (**ambient vibration seismology and passive imaging**). My goal is therefore to introduce and develop this innovative topic in the well-consolidated Master’s program of standard geophysical courses.