Analyzing seismic signals to understand volcanic mass flow emplacement

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Braden Michael Larson Walsh

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Abstract

Natural hazards are one of the greatest threats to life, industry, and infrastructure. It has been estimated that around a half billion people worldwide are in direct proximity to the danger of volcanic hazards. For volcanic mass flows, such as pyroclastic density currents and lahars, extreme runout distances are common. The close proximity of large population centers to volcanoes requires the implementation of early warning and real-time monitoring systems. A large portion of the progress towards real-time monitoring is through the use of geophysical instrumentation and techniques. This research looks into emerging geophysical methods and tries to better constrain and apply them for volcanic purposes. Specifically, multiple types of amplitude source location techniques are described and used for locating and estimating the dynamics of volcanic mass flows and eruptions. Other methods, such as semblance and back projection, are also employed. Applying the active seismic source method to a lahar that occurred on October 13th 2012 at Te Maari, New Zealand, locations and estimations of lahar energy were calculated in an increased noise environment. Additionally, the first ever calibration of the amplitude source location (ASL) method was conducted using active seismic sources. The calibration proved to decrease true error distances by over 50%. More calibration on the ASL method was accomplished by using all three components of the broadband seismometer. Initial results showed that using all three components reduced extreme errors and increase the overall precision of the locations. Finally, multiple geophysical methods (ASL, semblance, back projection, waveform migration, acoustic-seismic ratios) were used to show

that a combination of instrumentation could produce more reliable results. This research has filled gaps in the preexisting knowledge for hazards. With these results, more effective hazard warnings can be produced, and systems for real time estimations of locations and dynamics of volcanic events could be developed.

Dedication

While writing this thesis I was pondering whom I should dedicate this brilliant piece of work to. I dedicated my poorly wrote with lots of spelling errors Masters thesis to my family, and in some ways that is very fitting. Families are like that, they are not perfect, there is always someone messed up or something wrong going on, but in the end you hold them dearly and could not live with out them. I am not strictly applying this metaphor solely on my maters thesis, but rather to education in general. I believe education is the most valuable thing someone can have and even if it is not appealing they should not waste one moment of it. Trying to improve the future or society in anyway should be the ultimate goal for every person, because what better way is there to live life than trying to advance our species. In saying this, should I dedicate my thesis to the future? That seems really cheesy, so no, and if I really think about it, did I change society in any way or advance science in any way by completing this? No, not really, so did I just waste three years of my life? Well it depends on the person you ask. Should I then dedicate this to myself, because after all I am awesome? Maybe not, because that might be too much of an awesome move and put me into a legendary status. So then who or what gets the credit for my motivation for these last three years? At the end of the day when everything is said, all wrote up, and done, all I can do is dedicate this thesis to YOU, you the poor soul who reads this, you the poor soul who gets this thesis dropped in your lap and is forced to read this, you the poor soul who after forced reading this thinks my work is crap and thinks you can do better than me (and to you, I bet you can and please try your best), and finally to

you the sorry soul who if force to read this and gets any kind of useful information out of it to make your PhD, Masters, or educational path just that little bit easier, I dedicate this thesis.

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Table of Contents

List of figures

List of tables