Thesis Review: Joint Detection, Location and Source Mechanism Determination of Microseismic Events

sumitted by: Denis Anikev
Saint Petersberg State University

Reviewer: Kit Chambers

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The most widely used method for detection and location of microseismic sources from large areal surface arrays are imaging or stacking techniques. These techniques proceed by aligning and summing traces for speculative points and times in the sub-surface. The principle being that if a source occurred at that point and time then the energy will interfere constructively producing a large stack amplitude, whilst noise will interfere destructively producing a lower value. By aligning and summing for points in a 4D region (X,Y, Z and Time) one can identify sources that are not visible in the individual records. However, due to the anisotropic radiation energy from seismic sources, in many cases, these approaches generally produce an ambiguous image. In fact rather than obtaining a clear maximum at the true source position, one often obtains a lobed radiation pattern with a null at the true source position. This is because the source radiation pattern creates polarity reversals across the wavefront which in turn destructively cancel when the resulting traces are correctly aligned and summed. As result suboptimal location accuracy and event detectability are achieved.

In this thesis the candidate describes and applies an approach for correcting the radiation pattern from the seismic source and in so doing provides a method for joint detection, location and moment tensor determination of seismic events. They begin with a dis-

cussion of the basic concepts of joint detection and location. They then go further to discuss a method for determining location uncertainty from stack images and finally how a semi-automated workflow for processing data where by event detection is determined though semblance analysis. The contents of this thesis represent an important contribution to passive monitoring and I believe, after some minor corrections and typos, the thesis can be accepted.

The thesis is organised into 4 chapters. The introduction presents a background to the problem providing a discussion of previous work on the topic and motivation for the current work. Chapter 2 describes the methodology employed in the joint detection and location procedure as well as providing background information such as the moment tensor description of the seismic source. The chapter finishes with a discussion of the methodology for enhancing semblance as a detection metric. In Chapter 3 the developed technique is applied to a Microseismic dataset collected in the Arkoma basin and the results discussed; an overview of the study area is given, followed by a brief description of the calibration steps required for processing such a dataset. There is a comparison between the results of the proposed methodology and those of an existing location technique (maximum likelihood locations) and finally the proposed methodology is applied to the entire dataset. Chapter 4 presents the final conclusions for the work.

It is apparent from this work and the accompanying 12 external publications that Denis Anikev is a valuable member of the scientific community and has contributed original and thoughtful research. I wish him the best of luck with his defence and subsequent career.