I. INTRODUCTION

This thesis unifies and explains a new class of deconvolution techniques. These techniques estimate a linear operator that maximizes the spikiness of a suite of seismograms. The proposed method is derived from statistical theory and implemented using non-linear optimization techniques. It is an iterative multichannel method which has several important advantages over conventional deconvolution techniques. The minimum phase source and white reflectivity series assumptions are not required as only first order statistics are used. The non-Gaussianness of reflectivity series, a problem for other methods, is exploited to enhance the signal and suppress noise. For data with a low signal-to-noise ratio, the method has yielded results which are subjectively superior to those achieved with current techniques.

The thesis is divided into ten chapters. The second chapter briefly explains what seismograms are, who uses them, and why. The convolutional model is introduced, and the basic concepts and objectives of deconvolution are explained.

Chapter III is a summary of current techniques used for deconvolution. Direct, homomorphic, and predictive methods are reviewed. Some assumptions and problems associated with each are discussed.

In Chapter IV a geological rationale is given for our belief that the outputs of the deconvolution process should be non-Gaussian. The concepts of spikiness, entropy, and parsimony are related. Chapter V introduces a family of probability distributions and illustrates how the family is ordered by spikiness and entropy. Properties and estimators are derived from the family for later use.

Norm ratios previously proposed for deconvolution are introduced in Chapter VI. The variable norm ratio is then presented and several advantages and disadvantages listed. Properties of the proposed method for an infinite sample size and choice of parameters for the norm ratio are briefly covered.

In Chapters VII and VIII, non-linear optimization techniques are utilized to derive deconvolution algorithms which maximize the norm ratio. Properties of the algorithms and several simplifications are given. Time and frequency domain implementations are outlined and their relative advantages and disadvantages noted. Deconvolutions achieved using the implementations on synthetic and real data conclude each chapter.

Guidelines for choosing parameters and initializing the algorithms are proposed in Chapter IX. Methods for handling end effects, constraining the bandwidth of the inverse filter, and for estimating gain corrections are described. Finally, a short summary, several conclusions, and directions for further research are given in Chapter X.