Estimating an image of Galilee

Jon Claerbout, Stanford University

As a guest of Dan Lowenthal at TelAviv University in 1995 I received from Zvi benAvraham a survey of the Sea of Galilee. The data was charming for many unexpected reasons. Zvi had converted the data to a contour plot. I felt the use of industrial seismic display technologies along with inverse theory should enable me to find a better picture of the lake bottom. That turned out to be true, but I hadn't expected a decade to pass before my students and I came to a "good result", immune to data glitches and without ships tracks in the final image. Zvi informed us that the geological interpretation changed significantly as a result of our final image.

Our group concentrates on petroleum prospecting so you might find it surprising that we would frequently return to the Galilee depth soundings. These are depth values at each of 132,044 locations throughout the lake. We were charmed by this data for many reasons:

1. It is a tiny data set, about one megabyte, so it fits in anybody's computer.
2. Being tiny it is rapidly amenable to sophisticated analysis.
3. Crossing data acquisition lines can (and do) give inconsistent values.
4. The attempt to record data on a regular mesh does so, but crudely so.
5. Noises are not stationary.
6. The data contains large glitches, sometimes clustered.
7. Not only are there glitches in depth z but sometimes also in navigation coordinates (x, y).
8. Data values drift as though the lake evaporates and refills during the survey.
9. Basic binning operators always show survey tracks in the final image.
10. Without being burdened by the volume of 3-D seismic data this data raises many of the same issues, thereby being a good introduction to 3-D exploration seismology.

We achieved the goal of making a good image from this data without hand editing the data in any way. Our best result may be seen at http://sep.stanford.edu/sep/jon/galilee.jpg

My free on-line textbook on image estimation explains our work in full detail, along with many other interesting examples. I plan to summarize it in my talk. The data is available to everyone. More remains to be done.