A critical component of seismic hazard analysis is understanding the frequency and spatial distribution of earthquakes with different magnitudes on nearby faults. A framework for determining the optimal spatial distribution of earthquakes on a complex fault system is developed using combinatorial optimization methods. Input to the framework is a millennia-scale sample of earthquakes taken from a regional Gutenberg-Richter (G-R) relation. We then determine the optimal spatial arrangement of each earthquake in the fault system according to an objective function and constraints. Our previously published results focus on minimizing the total misfit in slip rates as the objective function; constraints were maximum and minimum slip rate values that incorporate uncertainty in slip-rate values for each fault. Both global and local combinatorial optimization methods have been developed to solve these problems: integer programming and the greedy sequential algorithm, respectively. Resulting on-fault magnitude distributions cannot be simply classified as being either purely characteristic or G-R. For example, faults may exhibit multiple "characteristic" magnitudes or a power-law distribution of magnitudes over a restricted range. Current research involves adapting the general combinatorial framework to include other and multiple objective functions, including minimizing the variation in accumulated stress over millennia. The framework can also accommodate branching and step-over connections for the slip-rate objective, while current research is underway to include interaction stress loading among the different faults in the fault system for stress-based objectives. Results from these methods are valuable for verifying the assumed magnitude-frequency distributions for faults in probabilistic seismic and tsunami hazard analyses.