2009 SCEC FINAL REPORT

SURVEY FOR NEW PRECARIOUS ROCKS IMPORTANT FOR TESTING CYBERSHAKE, NGA, AND HAZARD MAPS

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PBRS AND SEISMIC HAZARD

It has become clear that precariously balanced rocks (PBRs) provide important constraints on ground motion attenuation curves and seismic hazard. Because obtaining a statistically sufficient number of near-source recordings form very large earthquakes in a variety of tectonic environments may take many decades, precariously balanced rocks which have been in place thousands of years provide important constraints on ground motion attenuation curves and seismic hazard.

Hundreds of useful rocks have been documented in several papers published with SCEC and NEHRP funding. Additional papers have quantified the constraints from both the age and mechanical points of view. New attenuation curves (NGA) are somewhat more consistent with PBRs than the older attenuation curves, but the validity of these curves remains in question. Also, it has become clear that some of the statistical assumptions in PSHA give physically unreasonable answers when extrapolated to very low probabilities, a conclusion supported by precarious rock constraints. The new 2008 Seismic Hazard maps for 2% in 50 year probabilities appear to be inconsistent with many PBRs. Recently it has become accepted that future hazard maps will have to take into account the effect of an erroneous assumption about the connection between the spatial scatter of strong motion data, and the temporal scatter at a particular spatial site (the so-called ergodic assumption, Anderson and Brune, 1999). Determining how to make the correction will require verification from constraints on maximum low probability ground motion, such as constraints provided by precarious rocks.

Our surveys continue to provide important results. These include, in 2009, (1) documentation of more rocks in critical areas: near San Bernardino, Box Springs, south of Beaumont and Banning, Joshua Tree National Monument, Yucca Valley, and Black Mountain Road (San Jacinto Mountains). (2) quantitative improvements in the methodology, (3) improved understanding of the assumptions in PSHA. We have also assisted Dylan Rood and others in sample collection to document the old age of the rocks using cosmogenic age dating. Our results are strong evidence that PBRs provide important constraints for all of the new tools for estimating earthquake hazard.

IMPROVED TECHNIQUES FOR RECONNAISSANCE SURVEYS FOR PBRS

Initial surveys for precarious rocks involved automobile and foot surveys in conjunction with geologic maps. Since that time satellite coverage has greatly improved and become very useful in location of areas potentially useful for constraining earthquake hazard. However, satellite images are necessarily from near vertical, and thus cannot verify the shape of the rock base. Fortunately,

in the last couple of years we have developed a method for observing the shape of the base of rocks using single engine small planes. This is possible because of the increased resolution and speed of digital cameras (e.g., the Cannon D-20). This allows taking pictures from low flying planes at an angle of about 45 degrees, thus allowing observation of the rock base. This greatly improves the time (and hence financial) efficiency of PBR reconnaissance surveys. We have already located a number of critically important rocks using this technique. Of course final verification usually requires checking by foot. Richard Brune has also developed an improved method of digitizing the shapes of PBRs so that in many cases we will not have to return to the sites to determine the toppling accelerations.

Archive Improvements

We have now collected photographs for many important PBRs in Southern California. Our archive of pictures and meta-data was in serious need of updating to make it most useful for investigators. It could eventually be one of the most important Legacy products of SCEC. We created maps in large size of southern California to check locations and names, created a large timeline map, and scanned field notes into the archive. Special attention has been given to checking the documentation of particular areas and rocks important to constraining earthquake hazard.

CONCLUSION

We continued surveys for precarious rocks in areas important for constraining earthquake hazard. We used our improved methods of surveying to maximize the efficiency in terms of time and money. We made progress in correcting and updating our archive for Southern California PBRs. We have obtained important additional results in critical areas this year, results which are available for testing the new methods for estimating earthquake hazard.

Budget

Proposed start date:	February 1, 2008						
Year One Total:	15000						
SENIOR PERSONNEL SALARIES							
Employee	Units	Rate	Number	Subtotal	Benefit Rate	Benefits	
Jim Brune	Daily	1070	8	8560	0.04	342	
				8560		342	
Total Salary and Fringe							8902
Equipment Total							0
Consultants Total							0
Expendables		Rate	Days				0
	Field Supplies						
	Publication Costs				0		
Travel	Dest	Per trip	N. Trips	Subtotal	Total:		1793
	S. Calif.	600	2	1200			
	SCEC	593	1	593			
	AGU	0	1	0			
Additional Student Expenses				Number			
	Tuition and Fees per year						0
Total Direct Cost							10695
Indirect Cost Computation							
	Total Direct Cost			10695			
	Subtract Tuition & Fees			0			
	Subtract Equipment			0			
	Adjusted Total			10695			
	Fraction			0.4025			
	Indirect Cost						4305
Total							15000