DEC 0 9 1985

MEMORANDUM FOR: Leon Beratan, Chief
Earth Sciences Branch
Division of Radiation Programs
and Earth Sciences, RES

THRU: Andrew Murphy, Section Leader
Earth Sciences Branch
Division of Radiation Programs
and Earth Sciences, RES

FROM: Ina B. Alterman
Earth Sciences Branch
Division of Radiation Programs
and Earth Sciences, RES

SUBJECT: REPORT OF TRIP TO GEOLOGICAL SOCIETY OF AMERICA ANNUAL MEETING, OCTOBER 28-31, 1985

At the annual meeting of the Geological Society of America, October 28-31, 1985, I attended several presentations given by NRC contractors, former NRC contractors, or others on topics of interest to the NRC.

The following briefly summarizes some of the relevant presentations:

- Talwani, et. al.: The author presented a variety of geophysical and seismic data, and some stratigraphic determinations from the Charleston, S.C., area that resulted in defining a NW-trending graben bounded on one side by the Ashley River fault and cut by the NE-trending Woodstock fault. Isoseismals appear to define the graben. Paleoliquefaction studies and carbon dating suggest a recurrence interval of 1500-1700 yrs for the Charleston earthquake. The authors suggest that the two faults may have been involved in the Charleston 1886 earthquake.

- Colquhoun, et. al.: Sea level changes along coastlines can be distinguished by causative mechanisms, such as isostasy, eustacy (sea water volumetric changes) or tectonics, based on the known history, sediment structure and distribution, and comparison of world-wide sea level curves. The author focused on changes near Charleston, S.C. showing sporadic tectonic movements in the graben defined by Talwani which overprint larger scale eustatic movements. The total picture indicates change in rate of eustatic sea level rise from rapid to slow at about 6000 YBP.

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Earth Sciences Branch, DRPES

Enclosures:
As stated

cc: A. Murphy
S. Brocoum
L. Reiter
P. Sobel
R. Rothman
G. Giese-Koch

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RESULTS OF RECENT SEISMOTECTONIC STUDIES IN THE CHARLESTON AREA

TALWANI, Pradeep; COLQUHOUN, D.J. and LENNON, Gered, Geology Department, University of South Carolina, Columbia, S.C. 29208.

In order to understand the cause and nature of seismicity near Charleston we have examined an assortment of data. These include relocated hypocenters, potential field, seismic, shallow stratigraphic and releveling data, together with seismicity, releveling and paleoseismicity data. An evaluation of these data suggest the following:

1. A NW trending graben, of which one flank is possibly related to the buried (4-7 km) Ashley River fault (ARF).
2. The seismic reflection and hypocentral data suggest that the ARF is cut by the NNE trending Woodstock fault, which is downdropped to the NW.
3. The block defined by the Woodstock and ARF is postulated to represent the seismogenic feature responsible for seismicity.
4. The pattern of isoseismals of current felt earthquakes resembles the outline of the NW trending graben.
5. Historical and other data suggest that both sources were active in 1886.
6. The results of paleoseismological studies suggest a recurrent time of 1500-1700 Y. for similar events.

COMPARISON OF NEOTECTONIC DISTORTION WITH ISO- AND EUSTATIC SEA LEVELS IN MID - LATE HOLOCENE SOUTH CAROLINA

COLQUOHOUN, Donald J., TALWANI, Pradeep, LENNON, Gered, POLEY, Katie and BROOKS, Mark, Geology Dept., Univ. of S.C., Columbia, SC 29208

All coastlines reflect isostatic, (ice or water loading and unloading), tectonic (folding and faulting) and neotectonic (migration of the geoid) distortions through time. Thus Holocene sea-level change curves are unique and no general curve exists. Nevertheless eustatic changes (true changes in sea level itself through ice/water ratios on continental land masses, volume changes in ocean basins, specific gravity or volume changes in amount of ocean water) exist, and can be observed and estimated. They are probably related to global climatic changes within the Holocene through the Oligocene, and to sea-floor spreading as well, dominant prior to late Eocene. Our sea level change curve (1983) was developed through marsh stratigraphic and archeologic indicators between Georgetown and Savannah. Coincidence in time of change in NW Europe was noted. Some of the smaller fluctuations were thought eustatic. Detailed studies (1983-85) at Winyah Bay, Charleston and North and South Edisto reveal rapid sea rise (meters/1000 yrs) slowing near -6000 B.P. (cms/100 yrs) with small fluctuations (amplitude uncertain) continuing to the present. Tectonic distortion in our study area occurs in a graben landward between Goose Creek and Kiawah Island and hinged near Summerville. Sporadic movement began in the Thanetian and continues through the 1970's with movement remaining similiar. In spite of this, archeologic indicators (thought to reflect eustatic changes) within and without the graben express similiar clustering of dates, as does timing of rapid to slow change. Thus these eustatic movements generally exceed neotectonic, tectonic and isostatic distortion of this Coastal Plain, and prove eustatic rate change near -6000 B.P. (observed in the Pacific and elsewhere) and small eustatic fluctuations both here, N.W. Europe, Richmond Gulf and elsewhere.

BARRIER-ISLAND PROGRADATION AND THE 1100 BP SEA-LEVEL EVENT IN CENTRAL SOUTH CAROLINA

STAPOR, Frank W., Exxon Prod. Research Co., Box 2189, Houston, TX 77001; MATHEWS, Thomas D., MRRI, Box 12559, Charleston, SC 29412, and LINDSFORS-KEARNS, Fonda L., Louisiana Geological Survey, LSU Box G, Baton Rouge, LA 70893

Botany, Seabrook, Kiawah, and the Isle of Palms experienced significant seaward progradation during the period 1100-600 BP. The parallel beach ridges of Seabrook, Kiawah, and the Isle of Palms indicate direct onshore- while the curved, spit-type ridges of Botany indicate littoral-transport. Beach ridges making up these islands are primarily swash-zone deposits capped only locally with poorly developed dunes. Because these ridges are at an elevation quite similar to that of ridges formed over the past 50 years, sea level during their formation was at a position essentially equal to that of today. The marsh-buried beach ridges at Edisto Beach that were deposited about 1300 BP and the marsh-buried beach ridges at St. Phillips Island that contain 1000 BP pine stumps suggest a sea-level position somewhat lower than present-day. Thus, a significant rise in sea-level occurred at about 1100 BP, perhaps as much as 1 m, that was quickly followed, within 200 ^{14}C-years, by the initiation and/or progradation of Botany, Seabrook, and Kiawah. It is hypothesized that the adjustment of the nearshore equilibrium-profile necessitated by this rise was characterized by accelerated onshore- as well as littoral-transport, because the nearshore and shoreline are the only sources of sand in this region. The onset of progradation resulting from this sea-level event is dependent on the local rate at which sediment is supplied and this can vary from island to island. In central South Carolina island-wide progradation has ceased and now growth occurs only in those portions immediately adjacent to ebb-tidal deltas. A sea-level rise identical in age and similar in magnitude has been identified by the authors in southwest Florida.

№ 79196

LANDSLIDES IN THE NEW MADRID SEISMIC ZONE

JIBSON, Randall W., U.S. Geological Survey, Reston, VA 22092, and
KEEFER, David K., U.S. Geological Survey, Menlo Park, CA 94025

During the New Madrid earthquakes of 1811-12, bluffs bordering the Mississippi alluvial plain in the epicentral region underwent large-scale landsliding. Between Cairo, Ill. and Memphis, Tenn., we mapped 221 large (greater than 200 ft wide) landslides of three types: (1) old, eroded, coherent block slides and slumps; (2) old earth flows; and (3) young, fresh slumps that occur only along near-river bluffs and are the only landslides present along such bluffs.

Historical accounts and field evidence indicate that most or all old coherent slides and earth flows date to the 1811-12 earthquakes and that the only currently active, large-scale landsliding in the area occurs along bluffs bordering the river. Statistical analyses indicate that the regional distribution of these young, near-river slumps relates most strongly to slope steepness, a result of fluvial undercutting. Analysis of old coherent slides and earth flows indicates that landslide distribution is most strongly affected by slope height, but that proximity to the hypocenters of the 1811-12 earthquakes also has a significant effect.

Slope-stability analyses of an old coherent slide and an earth flow selected as representative of the principal kinds of landslides present indicate that both were stable in aseismic conditions even when water tables were at highest possible levels. However, a dynamic Newmark displacement analysis shows that ground shaking such as that in 1811-12 would cause large displacements leading to catastrophic failure in both slides. These results indicate that in large earthquakes landsliding in much of the study area is likely. Moderate ($m_b > 5.0$) earthquakes may also trigger landslides at some locations.

SEISMOTECHNISTRATIGRAPHIC CELLS: AN APPROACH TO THE ANALYSIS OF SUBSURFACE GEOLOGY AT ANCHORAGE, ALASKA, FOR USE IN SEISMIC ZONATION STUDIES

SCHMOLL, Henry R., ODUM, Jack K., and ESPINOSA, Alvaro F.,
U.S. Geological Survey, Box 25046, MS 972, Denver, CO 80225

Metropolitan Anchorage, Alaska, at the eastern margin of the upper Cook Inlet basin, is underlain by eastward-thinning sedimentary rocks and surficial deposits of Cretaceous through Holocene age that overlie a basement complex of metamorphic and (or) plutonic rocks of mainly Mesozoic age. Cook Inlet basin lies atop an active Benioff zone and is subject to major earthquakes. Synthesis of lithologic, thickness, geotechnical, and shear-wave data is needed to achieve a realistic seismic-zonation program for the region.

Present knowledge of the subsurface, based largely on borehole data of uneven distribution and quality, decreases exponentially with depth. Limited geologic and seismic cross-section data and knowledge of regional geology suggest a preliminary model useful for identifying data acquisition needs. The model is illustrated by the matrix shown below. The rows represent five numbered, wedge-shaped, subhorizontal stratigraphic units that comprise basement (1); shale (2); silt-, clay-, and sandstone (3); and older (4) and younger (5) Pleistocene glacial deposits including coarse (c) and fine (f) members that differ by age in character and distribution. The columns represent seven lettered seismotechnistratigraphic cells of different average thickness above basement, given in kilometers. Each cell is variably narrow and relatively long, and includes a unique combination of elements that are segments of the stratigraphic units.

G	F	E	D	C	B	A
2.7	2.1	1.5	0.9	0.5	0.1	0.02
5c	5f	5f	5fc	5c	5c	5c
4cf	4f	4fc	4c	4c	4c	1
3	3	3	3	3	1	
2	2	2	2	1		
1	1	1	1			

№ 71768

STRATIGRAPHIC AND GEOPHYSICAL EVIDENCE FOR A TERTIARY INTRUSION NEAR BEAUFORT, S. C.

MCCARTAN, Lucy, and GETTINGS, Mark E., U. S. Geological Survey, National Center, Reston, VA 22092

A mafic intrusion about 10 km in diameter at 1.5 km depth is indicated by strong positive gravity and magnetic anomalies and a closed structural high in overlying upper Eocene limestone near Beaufort, S. C. Sediments of Oligocene age northeast of Beaufort and of Miocene age to the west and southwest indicate that the "Beaufort high" divided the Southeast Georgia Embayment into two sub-basins by late Oligocene time. The stratigraphic relations and elevated geothermal gradients suggest an age of 20-30 Ma for the intrusion. Maintenance of the Beaufort high through time despite several marine incursions implies continued uplift, probably due to effects of the intrusion and Tertiary compressional warping. Intrusions with similar geophysical signatures are commonest in the southeast but are also present elsewhere along the Atlantic continential margin. Seismic profiles across the anomalies at the Clubhouse Crossroads deep corehole, 60 km north of Beaufort, show a flat Jurassic reflector, so the intrusive rocks there are Jurassic or older. However, 175 km northeast of Beaufort, a seismic line crossing one of the offshore anomalies shows an intrusion doming up Cenozoic sediments. Substantiation of a Tertiary age for the Beaufort pluton would significantly change the current models of the Tertiary tectonic history of the Southeast Georgia Embayment.

INVESTIGATION OF COMPRESSIONAL WAVE-INDUCED LIQUEFACTION

CHARLIE, W.A., Civil Engineering Dept., Colorado State University, Ft. Collins, CO 80523; DOEHRING, D.O., Earth Resources Dept., Colorado State University, Ft. Collins, CO 80523; VEYERA, G.E., Civil Engineering Dept., Colorado State University, Ft. Collins, CO 80523

Although most effort has been directed toward the study of liquefaction resulting from seismically-induced shear waves, natural and man-induced compressional waves are also capable of liquefying saturated sediments. The state-of-the-art for predicting such phenomena is at best limited. Although some empirical scaling factors have been determined from field tests, theoretical approaches are almost non-existent and have not been verified by experimental testing. A reliable means of predicting compressional wave liquefaction potential should find applications in mining, geophysical surveying, construction and the military.

We have taken two approaches, a laboratory physical model and a finite difference computer model. Both techniques allow for the use of a wide variety of materials and initiating forces and yield porewater pressure response. Our laboratory model consists of a compressed air cannon that propels a projectile into the sample. Transducers monitor strain and porewater pressure every fifty thousandths of a second for two seconds. The computer model is based on Newton's Second Law of Motion and couples a simple analytic locking model, to simulate the hysteretic behavior of the sediment skeleton, with a linear model to simulate the elastic behavior of the fluid. Our laboratory and computer models produce nearly identical results and both compare favorably with the meager empirical data available in the Russian and European literature.

THE ROLE OF PRECAMBRIAN

SUBSIDENCE PROBLEMS RELATED TO THE DEVELOPMENT OF SILICICLASTIC KARST ON THE CITRONELLE FORMATION OF SOUTHWESTERN ALABAMA

ISPHORDING, Wayne C., Department of Geology and Geography, University of South Alabama, Mobile, AL 36688 and FLOWERS, George C., Department of Geology, Tulane University, New Orleans, LA 70118

The irreversible transformation of kaolinite to gibbsite and the concomitant negative volume change associated with the reaction has resulted in residential structural damage in Mobile, Alabama. Failure of the insurance company to honor damage resulting from a "sinkhole collapse clause" resulted in litigation. The main points of contention in the trial were: (1) were the small depressions in the owner's yard caused by dissolution of material, resulting in the formation of subterranean voids?, (2) does the language used in the policy, i.e. "We cover for damages caused by sinkhole collapse due to the dissolution of limestone or similar rock formations." mean that because the Citronelle Sand is a rock formation (and assuming point (1) can be proved) that the resident should recover for damage to his house?

Evidence introduced for the plaintiff included X-ray diffractograms, SEM photographs and grain size analyses. A summary of literature on the development of karst in non-carbonate terranes was also produced (e.g., quartzite karst from Venezuela, volcanic karst in New Mexico and laterite karst from Australia. X-ray diffractograms indicated that gibbsite was being formed in the vadose zone; SEM photograps clearly revealed the presence of euhedral gibbsite crystals on both quartz grains and kaolinite. Size analyses were offered to disprove the allegation that the subsidence was a piping effect caused solely by removal of the silt component. Mass-balance equations and chemical analyses of groundwater were used to demonstrate that not only was kaolinite altering to gibbsite, causing loss of volume, but that some quartz was also being taken into solution. After consideration of the evidence, the jury found in favor of the plaintiff and the resident was compensated for damage.

then geologists.

POST PLIOCENE DISPLACEMENT ON FAULTS WITHIN THE KENTUCKY RIVER FAULT ZONE OF EAST-CENTRAL KENTUCKY

№ 62440

VanArsdale, Roy B., Geology Department, University of Arkansas, Fayetteville, AR 72701 and Sergeant, Richard E., Kentucky Geological Survey, Lexington, KY 40506

Numerous faults of the Kentucky River fault zone are partially overlain by Pliocene-Pleistocene terraces along the Kentucky river in east-central Kentucky. Preliminary drilling and electrical resistivity surveys suggest that a number of the faults have been active since the deposition of the terraces. From these preliminary surveys 4 sites were selected and 9 trenches were excavated. Of these 9 trenches, 4 revealed faulted and/or folded terrace sediments.

One trench was excavated across a N40W trending fault in southern Clark County, cutting 3m deep into a 10m thick terrace. A monoclinal flexure, clay dikes, an asymmetric anticline, and a thrust fault which offset a soil ped all were exposed in the trench wall. A second trench across this fault revealed a reverse fault which displaced the bedrock and the overlying terrace sediments by 1m. The third trench was excavated across a N60E trending fault in northern Madison County, exposing folded and faulted Lexington Limestone, overlain by alluvium-colluvium. A line of charcoal fragments, a line of barite nodules, and an underlying clay horizon in the alluvial-colluvial section appear to have locally folded with the underlying bedrock. Nearby, a fourth trench was excavated across another N60E trending fault revealing terrace folding and apparent faulting with 1m of reverse displacement.

Comparison of the 9 trenches indicates that the folding and faulting of the terrace deposits is tectonic in origin and that the Kentucky River fault zone has been active within the last 5 million years and probably within the last one million years. Recognition of relatively young faulting in Kentucky suggests that other mid-continent faults should be studied for recent displacement.

EXPERIMENTAL STUDY OF BONINITE GENESIS

№ 62917

VAN DER LAAN, Sieger R., FLOWER, Martin F.J., KOSTER VAN GROOS, August F., Department of Geological Sciences,

7615

REASSESSMENT OF THE STATE OF STRESS IN THE ATLANTIC COAST REGION

№ 64272

ZOBACK, Mary Lou, U.S. Geological Survey, 345 Middlefield Rd., Menlo Park, CA 94025, ZOBACK, Mark D., Dept. of Geophysics, Stanford Univ., Stanford, CA 94305, DART, Richard, U.S. Geological Survey, DFC, Denver, CO 80225

Results of previous studies have suggested that a zone of NW-oriented compression exists along the Atlantic seaboard of the U.S. in contrast to the NE-to ENE-oriented maximum horizontal stresses found throughout much of the midcontinent of North America. Poorly constrained earthquake focal mechanisms and late Tertiary offsets across reverse (?) faults were the primary evidence for this conclusion. New stress data, however, cast serious doubt on the existence of a distinct Atlantic coast stress province and suggest that the stress state characterizing the midcontinent region may be continuous into the midplate region of the western north Atlantic. These new data include: 1) analysis of borehole elongations ("breakouts") from exploration wells on the U.S. continental shelf which indicate a compressive stress orientation of approximately E-W in the Georges bank area (6 wells), N 55°-70° E in the Baltimore Canyon field (13 wells), and N 40° E in the southeast Georgia embayment (1 well); 2) borehole elongation analysis of about 20 wells in southeastern Canada and on the Scotian shelf indicating a N 50°-55° E compressive stress orientation (Plumb and Cox, 1984, EOS, p. 1081-1082); 3) better-constrained earthquake focal mechanisms obtained recently (Statton and others 1982, Eq. Notes, v. 53, p. 36; Talwani, 1982, GEOLOGY, v. 10, p. 654-658) and a re-analysis, including error assessment, of previous focal mechanisms in the New York-New Jersey area (Quittmeyer and others 1985, Eq. Notes, in press); and 4) hydraulic fracture measurements and borehole elongations in a 1 km deep well near the Ramapo fault in NY which suggest a N 55° E ± 10° maximum horizontal compressive stress orientation.

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6. The results of paleoseismological studies suggest a recurrent time of 1500-1700 Y. for similar events.

COMPARISON OF NEOTECTONIC DISTORTION WITH ISO- AND EUSTATIC SEA LEVELS IN MID - LATE HOLOCENE SOUTH CAROLINA

COLQUOHOUN, Donald J., TALWANI, Pradeep, LENNON, Gered, POLEY, Katie and BROOKS, Mark, Geology Dept., Univ. of S.C., Columbia, SC 29208

All coastlines reflect isostatic, (ice or water loading and unloading), tectonic (folding and faulting) and neotectonic (migration of the geoid) distortions through time. Thus Holocene sea-level change curves are unique and no general curve exists. Nevertheless eustatic changes (true changes in sea level itself through ice/water ratios on continental land masses, volume changes in ocean basins, specific gravity or volume changes in amount of ocean water) exist, and can be observed and estimated. They are probably related to global climatic changes within the Holocene through the Oligocene, and to sea-floor spreading as well, dominant prior to late Eocene. Our sea level change curve (1983) was developed through marsh stratigraphic and archeologic indicators between Georgetown and Savannah. Coincidence in time of change in NW Europe was noted. Some of the smaller fluctuations were thought eustatic. Detailed studies (1983-85) at Winyah Bay, Charleston and North and South Edisto reveal rapid sea rise (meters/1000 yrs) slowing near -6000 B.P. (cms/100 yrs) with small fluctuations (amplitude uncertain) continuing to the present. Tectonic distortion in our study area occurs in a graben landward between Goose Creek and Kiawah Island and hinged near Summerville. Sporadic movement began in the Thanetian and continues through the 1970's with movement remaining similiar. In spite of this, archeologic indicators (thought to reflect eustatic changes) within and without the graben express similiar clustering of dates, as does timing of rapid to slow change. Thus these eustatic movements generally exceed neotectonic, tectonic and isostatic distortion of this Coastal Plain, and prove eustatic rate change near -6000 B.P. (observed in the Pacific and elsewhere) and small eustatic fluctuations both here, N.W. Europe, Richmond Gulf and elsewhere.

№ 73489

BARRIER-ISLAND PROGRADATION AND THE 1100 BP SEA-LEVEL EVENT IN CENTRAL SOUTH CAROLINA

STAPOR, Frank W., Exxon Prod. Research Co., Box 2189, Houston, TX 77001; MATHEWS, Thomas D., MRRI, Box 12559, Charleston, SC 29412, and LINDSFORS-KEARNS, Fonda L., Louisiana Geological Survey, LSU Box G, Baton Rouge, LA 70893

Botany, Seabrook, Kiawah, and the Isle of Palms experienced significant seaward progradation during the period 1100-600 BP. The parallel beach ridges of Seabrook, Kiawah, and the Isle of Palms indicate direct onshore- while the curved, spit-type ridges of Botany indicate littoral-transport. Beach ridges making up these islands are primarily swash-zone deposits capped only locally with poorly developed dunes. Because these ridges are at an elevation quite similar to that of ridges formed over the past 50 years, sea level during their formation was at a position essentially equal to that of today. The marsh-buried beach ridges at Edisto Beach that were deposited about 1300 BP and the marsh-buried beach ridges at St. Phillips Island that contain 1000 BP pine stumps suggest a sea-level position somewhat lower than present-day. Thus, a significant rise in sea-level occurred at about 1100 BP, perhaps as much as 1 m, that was quickly followed, within 200 ^{14}C-years, by the initiation and/or progradation of Botany, Seabrook, and Kiawah. It is hypothesized that the adjustment of the nearshore equilibrium-profile necessitated by this rise was characterized by accelerated onshore- as well as littoral-transport, because the nearshore and shoreline are the only sources of sand in this region. The onset of progradation resulting from this sea-level event is dependent on the local rate at which sediment is supplied and this can vary from island to island. In central South Carolina island-wide progradation has ceased and now growth occurs only in those portions immediately adjacent to ebb-tidal deltas. A sea-level rise identical in age and similar in magnitude has been identified by the authors in southwest Florida.

LANDSLIDES IN THE NEW MADRID SEISMIC ZONE

JIBSON, Randall W., U.S. Geological Survey, Reston, VA 22092, and
KEEFER, David K., U.S. Geological Survey, Menlo Park, CA 94025

During the New Madrid earthquakes of 1811-12, bluffs bordering the Mississippi alluvial plain in the epicentral region underwent large-scale landsliding. Between Cairo, Ill. and Memphis, Tenn., we mapped 221 large (greater than 200 ft wide) landslides of three types: (1) old, eroded, coherent block slides and slumps; (2) old earth flows; and (3) young, fresh slumps that occur only along near-river bluffs and are the only landslides present along such bluffs.

Historical accounts and field evidence indicate that most or all old coherent slides and earth flows date to the 1811-12 earthquakes and that the only currently active, large-scale landsliding in the area occurs along bluffs bordering the river. Statistical analyses indicate that the regional distribution of these young, near-river slumps relates most strongly to slope steepness, a result of fluvial undercutting. Analysis of old coherent slides and earth flows indicates that landslide distribution is most strongly affected by slope height, but that proximity to the hypocenters of the 1811-12 earthquakes also has a significant effect.

Slope-stability analyses of an old coherent slide and an earth flow selected as representative of the principal kinds of landslides present indicate that both were stable in aseismic conditions even when water tables were at highest possible levels. However, a dynamic Newmark displacement analysis shows that ground shaking such as that in 1811-12 would cause large displacements leading to catastrophic failure in both slides. These results indicate that in large earthquakes landsliding in much of the study area is likely. Moderate ($m_b > 5.0$) earthquakes may also trigger landslides at some locations.

SEISMOTECHNISTRATIGRAPHIC CELLS: AN APPROACH TO THE ANALYSIS OF SUBSURFACE GEOLOGY AT ANCHORAGE, ALASKA, FOR USE IN SEISMIC ZONATION STUDIES

SCHMOLL, Henry R., ODUM, Jack K., and ESPINOSA, Alvaro F.,
U.S. Geological Survey, Box 25046, MS 972, Denver, CO 80225

Metropolitan Anchorage, Alaska, at the eastern margin of the upper Cook Inlet basin, is underlain by eastward-thinning sedimentary rocks and surficial deposits of Cretaceous through Holocene age that overlie a basement complex of metamorphic and (or) plutonic rocks of mainly Mesozoic age. Cook Inlet basin lies atop an active Benioff zone and is subject to major earthquakes. Synthesis of lithologic, thickness, geotechnical, and shear-wave data is needed to achieve a realistic seismic-zonation program for the region.

Present knowledge of the subsurface, based largely on borehole data of uneven distribution and quality, decreases exponentially with depth. Limited geologic and seismic cross-section data and knowledge of regional geology suggest a preliminary model useful for identifying data acquisition needs. The model is illustrated by the matrix shown below. The rows represent five numbered, wedge-shaped, subhorizontal stratigraphic units that comprise basement (1); shale (2); silt-, clay-, and sandstone (3); and older (4) and younger (5) Pleistocene glacial deposits including coarse (c) and fine (f) members that differ by age in character and distribution. The columns represent seven lettered seismotechnistratigraphic cells of different average thickness above basement, given in kilometers. Each cell is variably narrow and relatively long, and includes a unique combination of elements that are segments of the stratigraphic units.

G	F	E	D	C	B	A
2.7	2.1	1.5	0.9	0.5	0.1	0.02
5c	5f	5f	5fc	5c	5c	5c
4cf	4f	4fc	4c	4c	4c	1
3	3	3	3	3	1	
2	2	2	2	1		
1	1	1	1			

№ 71768

STRATIGRAPHIC AND GEOPHYSICAL EVIDENCE FOR A TERTIARY INTRUSION NEAR BEAUFORT, S. C.

MCCARTAN, Lucy, and GETTINGS, Mark E., U. S. Geological Survey, National Center, Reston, VA 22092

A mafic intrusion about 10 km in diameter at 1.5 km depth is indicated by strong positive gravity and magnetic anomalies and a closed structural high in overlying upper Eocene limestone near Beaufort, S. C. Sediments of Oligocene age northeast of Beaufort and of Miocene age to the west and southwest indicate that the "Beaufort high" divided the Southeast Georgia Embayment into two sub-basins by late Oligocene time. The stratigraphic relations and elevated geothermal gradients suggest an age of 20-30 Ma for the intrusion. Maintenance of the Beaufort high through time despite several marine incursions implies continued uplift, probably due to effects of the intrusion and Tertiary compressional warping. Intrusions with similar geophysical signatures are commonest in the southeast but are also present elsewhere along the Atlantic continential margin. Seismic profiles across the anomalies at the Clubhouse Crossroads deep corehole, 60 km north of Beaufort, show a flat Jurassic reflector, so the intrusive rocks there are Jurassic or older. However, 175 km northeast of Beaufort, a seismic line crossing one of the offshore anomalies shows an intrusion doming up Cenozoic sediments. Substantiation of a Tertiary age for the Beaufort pluton would significantly change the current models of the Tertiary tectonic history of the Southeast Georgia Embayment.

INVESTIGATION OF COMPRESSIONAL WAVE-INDUCED LIQUEFACTION

№ 5972

CHARLIE, W.A., Civil Engineering Dept., Colorado State University, Ft. Collins, CO 80523; DOEHRING, D.O., Earth Resources Dept., Colorado State University, Ft. Collins, CO 80523; VEYERA, G.E., Civil Engineering Dept., Colorado State University, Ft. Collins, CO 80523

Although most effort has been directed toward the study of liquefaction resulting from seismically-induced shear waves, natural and man-induced compressional waves are also capable of liquefying saturated sediments. The state-of-the-art for predicting such phenomena is at best limited. Although some empirical scaling factors have been determined from field tests, theoretical approaches are almost non-existent and have not been verified by experimental testing. A reliable means of predicting compressional wave liquefaction potential should find applications in mining, geophysical surveying, construction and the military.

We have taken two approaches, a laboratory physical model and a finite difference computer model. Both techniques allow for the use of a wide variety of materials and initiating forces and yield porewater pressure response. Our laboratory model consists of a compressed air cannon that propels a projectile into the sample. Transducers monitor strain and porewater pressure every fifty thousandths of a second for two seconds. The computer model is based on Newton's Second Law of Motion and couples a simple analytic locking model, to simulate the hysteretic behavior of the sediment skeleton, with a linear model to simulate the elastic behavior of the fluid. Our laboratory and computer models produce nearly identical results and both compare favorably with the meager empirical data available in the Russian and European literature.

THE ROLE OF PRECAMBRIAN

SUBSIDENCE PROBLEMS RELATED TO THE DEVELOPMENT OF SILICICLASTIC KARST ON THE CITRONELLE FORMATION OF SOUTHWESTERN ALABAMA

ISPHORDING, Wayne C., Department of Geology and Geography, University of South Alabama, Mobile, AL 36688 and FLOWERS, George C., Department of Geology, Tulane University, New Orleans, LA 70118

The irreversible transformation of kaolinite to gibbsite and the concomitant negative volume change associated with the reaction has resulted in residential structural damage in Mobile, Alabama. Failure of the insurance company to honor damage resulting from a "sinkhole collapse clause" resulted in litigation. The main points of contention in the trial were: (1) were the small depressions in the owner's yard caused by dissolution of material, resulting in the formation of subterranean voids?, (2) does the language used in the policy, i.e. "We cover for damages caused by sinkhole collapse due to the dissolution of limestone or similar rock formations." mean that because the Citronelle Sand is a rock formation (and assuming point (1) can be proved) that the resident should recover for damage to his house?

Evidence introduced for the plaintiff included X-ray diffractograms, SEM photographs and grain size analyses. A summary of literature on the development of karst in non-carbonate terranes was also produced (e.g., quartzite karst from Venezuela, volcanic karst in New Mexico and laterite karst from Australia. X-ray diffractograms indicated that gibbsite was being formed in the vadose zone; SEM photograps clearly revealed the presence of euhedral gibbsite crystals on both quartz grains and kaolinite. Size analyses were offered to disprove the allegation that the subsidence was a piping effect caused solely by removal of the silt component. Mass-balance equations and chemical analyses of groundwater were used to demonstrate that not only was kaolinite altering to gibbsite, causing loss of volume, but that some quartz was also being taken into solution. After consideration of the evidence, the jury found in favor of the plaintiff and the resident was compensated for damage.

then geologists.

POST PLIOCENE DISPLACEMENT ON FAULTS WITHIN THE KENTUCKY RIVER FAULT ZONE OF EAST-CENTRAL KENTUCKY

Nº 62440

VanArsdale, Roy B., Geology Department, University of Arkansas, Fayetteville, AR 72701 and Sergeant, Richard E., Kentucky Geological Survey, Lexington, KY 40506

Numerous faults of the Kentucky River fault zone are partially overlain by Pliocene-Pleistocene terraces along the Kentucky river in east-central Kentucky. Preliminary drilling and electrical resistivity surveys suggest that a number of the faults have been active since the deposition of the terraces. From these preliminary surveys 4 sites were selected and 9 trenches were excavated. Of these 9 trenches, 4 revealed faulted and/or folded terrace sediments.

One trench was excavated across a N40W trending fault in southern Clark County, cutting 3m deep into a 10m thick terrace. A monoclinal flexure, clay dikes, an asymmetric anticline, and a thrust fault which offset a soil ped all were exposed in the trench wall. A second trench across this fault revealed a reverse fault which displaced the bedrock and the overlying terrace sediments by 1m. The third trench was excavated across a N60E trending fault in northern Madison County, exposing folded and faulted Lexington Limestone, overlain by alluvium-colluvium. A line of charcoal fragments, a line of barite nodules, and an underlying clay horizon in the alluvial-colluvial section appear to have locally folded with the underlying bedrock. Nearby, a fourth trench was excavated across another N60E trending fault revealing terrace folding and apparent faulting with 1m of reverse displacement.

Comparison of the 9 trenches indicates that the folding and faulting of the terrace deposits is tectonic in origin and that the Kentucky River fault zone has been active within the last 5 million years and probably within the last one million years. Recognition of relatively young faulting in Kentucky suggests that other mid-continent faults should be studied for recent displacement.

EXPERIMENTAL STUDY OF BONINITE GENESIS

Nº 62917

VAN DER LAAN, Sieger R., FLOWER, Martin F.J., KOSTER VAN GROOS, August F., Department of Geological Sciences,

7615

REASSESSMENT OF THE STATE OF STRESS IN THE ATLANTIC COAST REGION

№ 64272

ZOBACK, Mary Lou, U.S. Geological Survey, 345 Middlefield Rd., Menlo Park, CA 94025, ZOBACK, Mark D., Dept. of Geophysics, Stanford Univ., Stanford, CA 94305, DART, Richard, U.S. Geological Survey, DFC, Denver, CO 80225

Results of previous studies have suggested that a zone of NW-oriented compression exists along the Atlantic seaboard of the U.S. in contrast to the NE-to ENE-oriented maximum horizontal stresses found throughout much of the midcontinent of North America. Poorly constrained earthquake focal mechanisms and late Tertiary offsets across reverse (?) faults were the primary evidence for this conclusion. New stress data, however, cast serious doubt on the existence of a distinct Atlantic coast stress province and suggest that the stress state characterizing the midcontinent region may be continuous into the midplate region of the western north Atlantic. These new data include: 1) analysis of borehole elongations ("breakouts") from exploration wells on the U.S. continental shelf which indicate a compressive stress orientation of approximately E-W in the Georges bank area (6 wells), N 55°-70° E in the Baltimore Canyon field (13 wells), and N 40° E in the southeast Georgia embayment (1 well); 2) borehole elongation analysis of about 20 wells in southeastern Canada and on the Scotian shelf indicating a N 50°-55° E compressive stress orientation (Plumb and Cox, 1984, EOS, p. 1081-1082); 3) better-constrained earthquake focal mechanisms obtained recently (Statton and others 1982, Eq. Notes, v. 53, p. 36; Talwani, 1982, GEOLOGY, v. 10, p. 654-658) and a re-analysis, including error assessment, of previous focal mechanisms in the New York-New Jersey area (Quittmeyer and others 1985, Eq. Notes, in press); and 4) hydraulic fracture measurements and borehole elongations in a 1 km deep well near the Ramapo fault in NY which suggest a N 55° E ± 10° maximum horizontal compressive stress orientation.