ΤΑ ΝΕΑ ΤΗΣ ΕΕΕΕΘ

ΕΛΛΗΝΙΚΗ ΕΠΙΣΤΗΜΟΝΙΚΗ ΕΤΑΙΡΕΙΑ ΕΔΑΦΟΜΗΧΑΝΙΚΗΣ ΚΑΙ ΘΕΜΕΛΙΩΣΕΩΝ

Επί του «πιεστηρίου»:

Ενεκρίθη από το Πρωτοδικείο Αθηνών η τροποποίηση του καταστατικού της ΕΕΕΕΘ, η οποία αφορά στο όνομα, που πλέον γίνεται «ΕΛΛΗΝΙΚΗ ΕΠΙΣΤΗΜΟΝΙΚΗ ΕΤΑΙΡΕΙΑ ΕΔΑΦΟΜΗΧΑΝΙΚΗΣ ΚΑΙ ΓΕΩΤΕΧΝΙΚΗΣ ΜΗΧΑΝΙΚΗΣ» και στον τρόπο διεξαγωγής των αρχαιρεσιών για την ανάδειξη των μελών της Εκτελεστικής και της Εξελεγκτικής Επιτροπής (δυνατότητα ταχυδρομικής αποστολής ψηφοδελτίου).

Περιεχόμενα

Ανασκόπηση Γεγονότων Γεωτεχνικού Ενδιαφέροντος 1
- Ημερίδα «Εφαρμογές Γεωσυνθετικών Υλικών» 1
- Ημερίδα «Νέες Εξελιγμένες Μέθοδοι Μηχανικής Διάνοιξης Σηράγγων» 2

Προσεχείς Επιστημονικές Εκδηλώσεις 3
- 2ο Ιαπωνο–Ελληνικό Συμπόσιο: Αντισεισμικός Σχεδιασμός, Παρατήρηση Συμπεριφοράς, και Αναβάθμιση Θεμελιώσεων 3
- 3rd Symposium on Construction Processes in Geotechnical Engineering 3
- International Symposium on Seismic Risk Reduction / JICA Technical Cooperation Project in Romania 3
- ITA – AITES World Tunnel Congress 2007 "Underground Space – the 4th Dimension of Metropolises" and the 33rd ITA – AITES General Assembly 4
- 4th International Conference on Earthquake Geotechnical Engineering 4
- 11th Congress of the International Society For Rock Mechanics 4
- Dam Safety 2007 5
- 11th ACUUS Conference "Underground Space Expanding the Frontiers" 6
- Euro: Tun 2007 Computational Methods in Tunnelling 6
- International Symposium on Studies on Historical heritage 7
- XIV European Conference on Soil Mechanics and Geotechnical Engineering 7
- 7th International Symposium on Field Measurements in Geomechanics 7
- 56th Geomechanics Colloquium 2007 8
- Hydro 2007 8
- First International Symposium on Geotechnical Safety & Risk 8
- International Conference on Ground Anchorages and Anchored Structures in Service 2007 9
- GeoAmericas 2008 9
- GeoCongress '08 9
- VI International Symposium "Geotechnical Aspects of Underground Construction in Soft Ground – IS - Shanghai 2008 10
- 6th International Conference on Case Histories in Geotechnical Engineering and Symposium in Honor of Professor James K. Mitchell 10
- 2008 World Tunnel Congress "Underground Facilities for Better Environment & Safety" and 34th ITA General Assembly 11
- The 12th International Conference of IACMAG 11
- IX International Conference on Geosynthetics 12
- XVII International Conference on Soil Mechanics and Geotechnical Engineering 12

Διεθνή Νέα 12
- Sao Paulo subway collapse 12
- Προβλήματα τύπου Εκτροπής Αχελώου υπάρχουν και αλλού … 15
- Εντυπωσιακές Νέες Κτιριακές Κατασκευές - La Phare Tower illuminates La Défense 15
- Η Κοσμογονία του Dubai - Dubai Towers Unveiled 16

Διακρίσεις – Ανάληψη Προεδρίας και Γραμματείας CEN/TC 341 17

Ενημερωτικά - Επιστημονικά Άρθρα
Bimrocks – Part 1: Introduction 17

Νέες Εκδόσεις 22

Ανασκόπηση Γεγονότων Γεωτεχνικού Ενδιαφέροντος

Ημερίδα «Εφαρμογές Γεωσυνθετικών Υλικών»

Στα πλαίσια των δραστηριοτήτων της Ειδικής Επιστημονικής Εδαφομηχανικής και Θεμελιώσεων του ΤΕΕ, συνδιοργανώθηκε από το ΤΕΕ και την Ελληνική Εταιρεία Γεωσυνθετικων Υλικών (HGS) ημερίδα

Διακρίσεις

Ανάληψη Προεδρείας και Γραμματείας Κανονιστικής Τεχνικής Επιτροπής CEN / TC 341

Στα πλαίσια της συμμετοχής του στην Ευρωπαϊκή Κανονιστική διαδικασία, ο ΕΛΟΤ ανέλαβε τον Οκτώβριο του 2006 από τη CEN τη Γραμματεία της Κανονιστικής Τεχνικής Επιτροπής CEN/TC 341 «Διερεύνηση του Υπεδάφους: Εργαστηριακές και Επιτόπου Δοκιμές». Ως Γραμματέας της ανωτέρω Επιτροπής ορίστηκε ο συνάδελφος και μέλος της ΕΕΕΕΘ Πρόδρομος Ψαρρόπουλος, Δρ. Πολιτικός Μηχανικός ΕΜΠ. Την Γραμματεία της TC 341 κατείχε την τελευταία εξαετία ο Γερμανικός Οργανισμός DIN, με Γραμματέα τον κ. R. Cors και Πρόεδρο τον Καθηγητή κ. R. Katzenbach. Η ανωτέρω επιτροπή, καθώς και η Επιτροπή CEN/TC 288: «Ειδικά Γεωτεχνικά Έργα», είναι ουσιαστικά συμπληρωματικές Επιτροπές του Ευρωκώδικα 7: Γεωτεχνικός Σχεδιασμός.

Στα μέσα Ιανουαρίου 2007 πραγματοποιήθηκε στην Αθήνα, με την διοργάνωση του ΕΛΟΤ, συνεδρίαση της TC 341, στην οποία παρέστησαν 15 εκπρόσωποι των χωρών-μελών της Ευρωπαϊκής Ένωσης. Κατά τη συνάντηση αυτή έγινε και εκλογή για ανάδειξη νέου Προέδρου της TC 341, για την τριετία 2007 – 2010. Ο εκπρόσωπος του ΕΛΟΤ στην υπ' όψη Επιτροπή συνάδελφος Ανδρέας Αναγνωστόπουλος, Ομότιμος Καθηγητής ΕΜΠ και Γενικός Γραμματέας της ΕΕΕΕΘ, εξελέγη παμψηφεί ως Πρόεδρος.

Ενημερωτικά - Επιστημονικά Άρθρα

Bimrocks – Part 1: Introduction

Edmund W. Medley

(Senior Consultant, Geosyntec Consultants, Oakland, California, USA; emedley@geosyntec.com)

INTRODUCTION

Bimrocks (block-in-matrix rocks) include weathered rocks, fault rocks, and melanges. Bimrocks can be found in many geologic regions of the world, including Northern Greece and many Greek Isles. Despite different formative processes, these globally common soil/rock mixtures have a similar fabric of relatively hard blocks of rock surrounded by weaker matrix rocks. Characterization, design and construction with in bimrocks is challenging because of their considerable spatial, lithological and mechanical variability, and geotechnical engineers and engineering geologists often mischaracterize them.

Two articles are presented in this Bulletin to increase awareness by geotechnical engineers. Recognition of bimrocks and implementation of the available procedures for their characterization may result in significant reduction in the expensive surprises that often occur in slope and landslide analyses, and in the design and construction of foundations, earthwork, deep excavations and tunnels. This first article presents some fundamental attributes of bimrocks. In the next Bulletin, the second article will present case history experiences and some guidelines to characterization.

The information presented in the articles is abstracted from comprehensive resources freely provided at http://bimrocks.geoengineer/resources.html .

TYPES OF BIMROCKS

The term "block-in-matrix rocks" was originally coined by Raymond (1984) for melanges and olistostromes, geological words which have firm and important connotations for geologists but are generally meaningless to engineers. To focus on the fundamental engineering problems related to the characterization of these and many other "rock/soil" mixtures, Medley (1994) coined the neutral word "bimrocks", which has no geological connotations. Bimrocks are defined as *"a mixture of rocks, composed of geotechnically significant blocks within a bonded matrix of finer texture."* The expression "geotechnically significant blocks" means that there is mechanical contrast between blocks and matrix, and the volume and size of the blocks influence the rock mass properties at the scales of engineering interest.

Bimrocks are widespread and include weathered rocks, which are mixtures of decomposed soil surrounding fresher corestones (Figure 1). Fault rocks (Figure 2) exist at many scales, with blocks ranging between several tens to hundreds of meters in size to millimeter-sized fragments within gouge (Riedmüller et al, 2001, 2004). Melanges (French: *mélange* or "mixture") are heterogeneous, complex geological mixtures containing competent blocks of varied lithologies, embedded in sheared matrices of weaker rock (Figure 3). Melanges and olistostromes are found in over 60 countries and are associated with mountainous areas in ancient and modern tectonic subduction zones (including Greece, Crete, Italy and Turkey: Medley, 1994). Although the geological literature contains thousands of references on melanges, there are few treatments related to geoengineering (Medley, 1994).

Figure 1: Decomposed granite: a weathered rock located in the Sierra Nevada mountains of California. Hard blocks (corestones) surrounded by "gruss", granite completely decomposed to dense sandy soil. (Photo: E. Medley).

Figure 2: Wall of a quarry located within major fault zone, California. Sheared rock surrounds hard blocks of relatively intact rock. Blocks range between centimeters to tens of meters in size. (Photo: E. Medley/Geosyntec Consultants).

Figure 3: Franciscan Complex melange, northern California. Blocks buttress base of slope between landslides in sheared shale matrix. (Photo: E, Medley/Exponent, Inc.).

Geoengineers often neglect the contributions of blocks to overall bimrock strength, choosing instead to design on the basis of the strength of the weak matrix. However, this practice may be too conservative for many bimrocks and often results in ignoring the presence of blocks altogether, to the detriment of accurate characterizations. As block proportions increase, stiffness increases and deformation decreases depending on the relative orientation of blocks to applied stresses (Lindquist, 1994; Lindquist and Goodman, 1994). Stress distributions in bimrocks depend on the lithologies; size distributions; orientations and shapes of blocks; and the orientations of matrix shears, all of which influence slope stability (Medley and Sanz, 2004) and underground excavations (Button et al, 2003: Moritz et al, 2004; Riedmueller and Schubert, 2002).

SOME ENGINEERING CHARACTERISTICS OF MELANGES

The melanges of the Franciscan Complex (the Franciscan") of northern California are similar to melanges in appearance, properties and the problems they present globally to geoengineers. Melanges are the most difficult of bimrocks to characterize, hence lessons learned from studies of Franciscan melanges can be applied to the characterization of other, more tractable bimrocks. The matrix of Franciscan melanges is composed of shale, argillite, siltstone, serpentinite or sandstone, sometimes pervasively sheared to the consistency of soil. Landslides are common in block-poor Franciscan melanges (Medley and Sanz, 2004) but large blocks appear to add buttress support (Figure 3).

Medley (1994) estimated that the greatest proportion of blocks in Franciscan melanges were greywacke sandstone, with lesser proportions of volcanic, chert, serpentininite, limestone and exotic metamorphic blocks. Large blocks in melanges and fault rocks tend to be ellipsoidal to irregular in shape. Blocks are relatively erosion-resistant and often protrude above the ground surface in melange landscapes, a characteristic of melanges also evident in Greece (Figure 4).

The weakest elements in bimrocks are the contacts between blocks and matrix (Figure 5). Only modest mechanical contrast between competent blocks and weaker matrix is required to force failure surfaces to negotiate tortuously around blocks (Medley, 1994; Sönmez et al, 2004, 2006a, 2006b). Matrix shears generally pass around blocks via the block/matrix contacts (Figure 6) with the most intense shearing often present adjacent to the largest blocks. Blocks within the shears are often entrained within, and oriented sub-parallel, to shears. Since shears have a tortuous path through the rocks mass, the overall orientation of entrained blocks can also abruptly change from place to place within the rockmass.

Figure 4; Blocks in melange protrude from hillside along proposed right-of-way, Egnatia Highway, Greece. (Photo: late Professor Gunter Riedmueller/GGG, Austria)

Figure 5: Weakest element in a bimrock is generally the block/matrix contact. Gwna Melange, Anglesey, Wales. (Photo: E. Medley).

PROBLEMS WITH MAPPING AND DRILLING OF BIMROCKS

A very common error is to map outcrops in melanges, fault rocks and other bimrocks as part of continuous strata, although that mistake is less likely to be made by a knowledgeable geologist (Wakabayashi and Medley, 2004). When mapped, the largest dimension of exposed blocks can be recorded. When drilled, the block dimensions are indicated by chords, the lengths of the intersection between blocks and the drilled core. However, the observed dimensions of blocks generally underestimate their "sizes" (Figure 6). Accordingly, the word "size" or "diameter" should not be used when describing the dimensions of blocks, unless those are known.

Having a mental picture like Figure 6 is essential when characterizing bimrocks. Despite the apparent interlayered appearance of drill core recovered from bimrocks, it is preferable not to log borings in bimrocks with expressions such as "interbedded shales and sandstones" since this term implies stratal continuity (Figure 6). Boring logs in bimrocks provide suspect basis for drawing continuous stratigraphic contacts between borings, such as shown in Figure 7 (Wakabayashi and Medley, 2004).

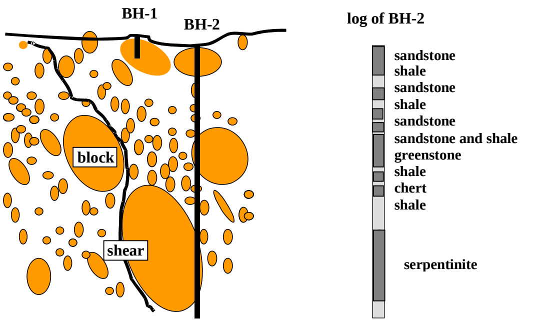


Figure 6: Block/core intersections (chords) do not generally indicate true block sizes. Sandstone/shale sequence in core is not "interbedded shale and sandstone"!! Improbable juxtaposition of rocks (e.g.: greenstone and shale) strongly suggest melange. Note that shears in the matrix negotiate tortuously around blocks.

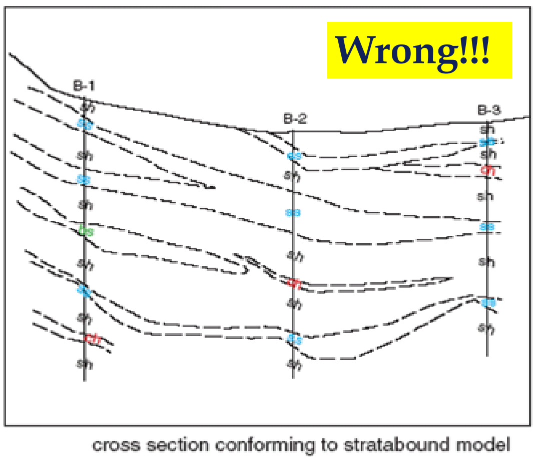


Figure 7: Bimrocks generally cannot be accurately characterized on cross-sections (Wakabayashi and Medley, 2004). Borehole contacts should be shown with question marks and not connected between borings.

WHAT IS BLOCK AND WHAT IS MATRIX?

It is important to recognize that block sizes in Franciscan melanges (which are typical of melanges world-wide) can exceed seven orders of magnitude, ranging between millimeters and tens of kilometers (Medley, 1994; Medley and Lindquist, 1995). Figure 8 and its insert are photographs taken at different scales of the same outcrop of Franciscan melange. Small blocks at one scale of interest (detail photo in Figure 8) are part of the matrix at the larger scale photo of Figure 8. Blocks at one scale that are assigned to matrix do not contribute to the mechanical behavior of the bimrock and relative to the definition of bimrocks, are not "geotechnically significant" at that scale, although they may be at larger scales.

Since blocks exist at many scales of engineering interest in bimrocks: what is block and what is matrix? Because of the scale independence of block sizes (Medley and Lindquist, 1995) a "*characteristic engineering dimension*, L_c" must be defined (Medley, 1994) which is analogous to the scale bar in the insert photograph of Figure 8. The characteristic engineering dimension changes as scales of interest change at a project. L_c may variously be: 1) an indicator of the size of the entire site, such as the square root of A ($\sqrt{A}$) where A is the area of the site; 2) the size of the largest block (d_{max}) at the site; 3) the thickness of a failure zone beneath a landslide; 4) the height of a slope or excavation; 5) a tunnel diameter; 6) a footing width or; 7) the dimension of a laboratory specimen; and so on.

See errata: click here

Figure 8: Franciscan Complex melange, northern California. Note shearing in "matrix" adjacent large headland block with blocks oriented sub-parallel to shearing. Block sizes range between tens of meters and meters. Detail shows "matrix" in at circled area also has block-in-matrix fabric at scale of 3.1 meter long bar. (Photo: E. Medley).

The smallest geotechnically significant block within a volume of bimrock is about 0.05 L_c, which is the threshold size between blocks and matrix at the chosen scale (Medley, 1994). For any given volume of bimrock, blocks smaller than 0.05 L_c constitute greater than 95 percent of the total number but contribute less than 1 percent to the total volume of bimrock and thus have negligible effect on the bimrock strength. The largest block (d_{max}) is approximately 0.75 L_c .

BIMROCK STRENGTH

Geotechnical engineers and engineering geology practitioners commonly follow soil mechanics tradition and assume that the mechanical behavior of bimrocks is adequately represented by the properties of the weak matrix materials. In many circumstances, this assumption is too conservative. Lindquist (1994) and Lindquist and Goodman (1994) determined that the overall strength of a bimrock is related to the volumetric proportions of the blocks. As shown in Figure 9, Lindquist (1994) conservatively established that below about 25 percent volumetric block proportion the strength and deformation properties of a bimrock is that of the matrix; between about 25 percent and 75 percent, the friction angle and modulus of deformation of the bimrock mass proportionally increase (and cohesion decreases); and, beyond 75 percent block proportion, the blocks tend to touch and there is no further increase in bimrock strength. Goodman and Ahlgren (2000) identified contributions to overall bimrocks strength at volumetric block proportions much lower than 25 percent.

The overall strength of a bimrock is independent of the strength of the blocks. Blocks greater than the block/matrix threshold contribute to strength: as long as there is sufficient mechanical contrast, the presence of blocks with a range of sizes adds strength to a bimrock by forcing tortuous failure surfaces to tortuously negotiate around blocks (Irfan and Tang, 1993; Lindquist, 1994; Lindquist and Goodman, 1994; Goodman and Ahlgren, 2000; Sönmez, et al, 2006a, 2006b).

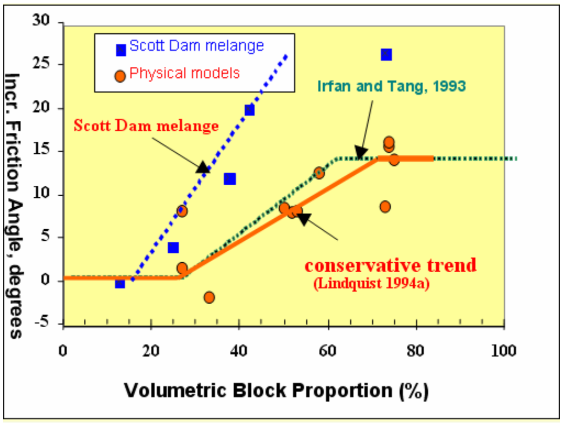
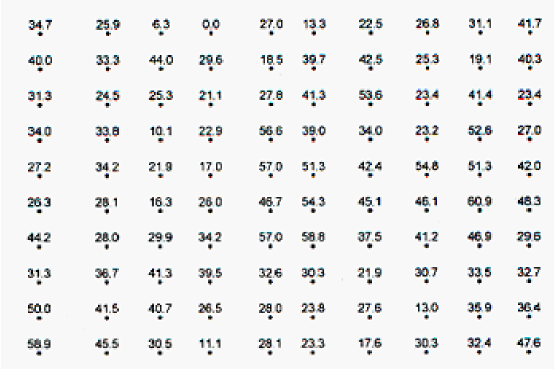


Figure 9: Strength of bimrocks increases with volumetric block proportion. The increase is added to the strength of the matrix. (After Medley, 1999; from data of Lindquist, 1994a; Irfan and Tang, 1993).

ESTIMATION OF VOLUMETRIC BLOCK PROPORTIONS

As indicated above, to predict the mechanical properties of bimrocks, the volumetric block proportion must be estimated. The volumetric block proportion of a bimrock can be approximated by measuring linear block proportions of drilled cores which, given enough sampling, are equivalent to volumetric proportions (Weibel, 1980, Medley, 1994). The linear block proportion is the ratio of the total lengths of blocks intersected to the total length of sample lines. Other methods include measurement of the areal block proportions from outcrops using image analysis (Medley, 1994). However, erroneous estimates will result if volumetric block proportions, bimrocks strengths, and total block volumes are estimated from a few borings (or outcrops), as indicated by the typically extreme variability indicated by Figure 10. During earthwork construction very useful information may be collected to refine the strength estimate of the bimrock and evaluate the assumptions made (Medley, 1997).



See errata: click here

Figure 10: Plan view of an array of 100 linear block proportions ranging between 0% and 61% measured for a physical model bimrock with actual volumetric block proportion of 32%. The range in spatial variability is indicated by the circled values (After Medley, 1997).

CONCLUSIONS

Bimrocks are common and problematic for geotechnical engineers in many countries, including Greece. Bimrocks should be purposefully characterized for design and construction even where there is great uncertainty in the characterization, or when the volumetric proportion of blocks is too little to provide geomechanical benefit. Conceptual understanding of the nature of bimrocks aids accurate characterizations. Procedures to characterize and analyze bimrocks are available. Implementation of these procedures may reduce expensive surprises by focusing the practitioner's attention on the difficulties that may be encountered during design and construction.

The second article in this series will present case histories and some guidelines for performing disciplined characterizations of bimrocks. Readers with questions arising from this first article may email the author at emedley@geosyntec.com and where possible answers will be included in the next article.

ACKNOWLEDGEMENTS

I am grateful to Dr. Christos Tsatsanifos and Dr. Dimitrios Zekkos for encouraging me to write these articles. I also appreciate the review comments of Dr. Zekkos, Amy Padovani and Tony Dover.

BIOGRAPHY

Dr. Edmund Medley is a Senior Consultant with Geosyntec Consultants, Inc. (www.geosyntec.com) Dr. Medley has over 30 years of international experience in geological and geotechnical engineering, and is professionally licensed as both an engineer and geologist in the USA, Canada and the United Kingdom. He has contributed to over 30 publications, presented more than 100 lectures, taught several Short Courses, testified at trials and in depositions, appeared in TV documentaries, and

Photo: Geosyntec Consultants

is an Editor of two international geoengineering Journals.

REFERENCES

*References shown **in Bold** are available at* *http://bimrocks.geoengineer.org/resources.html*

Button, E. A., Schubert, W., Riedmueller, G., Klima, K. & Medley, E.W., 2003; "Tunnelling in tectonic melanges – accommodating the impacts of geomechanical complexities and anisotropic rock mass fabrics"; international Bulletin of Engineering Geology and the Environment.

Goodman, R.E., and Ahlgren, C.S., 2000; "Evaluating the safety of a concrete gravity dam on weak rock-Scott Dam", *Journal of Geotechnical and Geoenvironmental Engineering*, v. 126, p. 429-442; with Discussion (by J. H. Hovland, E.W. Medley and R.L. Volpe; and Authors), v. 127, October 2000, p. 900-903.

Irfan, T.Y. and Tang, K.Y., 1993; "Effect of the coarse fraction on the shear strength of colluvium in Hong Kong"; TN 4/92, Hong Kong Geotechnical Engineering Office, 128 p.

Lindquist, E.S., 1994; "The strength and deformation properties of melange": Ph.D. Dissertation; Dept. of Civil Engineering, Univ. California at Berkeley, California, 262 p.

Lindquist, E.S. and Goodman, R.E., 1994; "The strength and deformation properties of a physical model melange"; in Proc. 1st North American Rock Mechanics Conference (NARMS), Austin, Texas; ed. Nelson, P.P. and Laubach, S.E., A.A. Balkema, Rotterdam.

Medley, E.W., 1994; "The engineering characterization of melanges and similar block-in-matrix rocks (bimrocks)", Ph.D. dissertation; Dept. of Civil Engineering, University of California at Berkeley, California; 387 p.

Medley, E.W., 1997; "Uncertainty in estimates of block volumetric proportion in melange bimrocks"; in Proc. Int. Symp. of Int. Assoc. Eng. Geol., Athens, Greece; June 23-27; A.A. Balkema, Rotterdam.

Medley, E.W., 2002; "Estimating block size distributions of melanges and similar block-in-matrix rocks (bimrocks)", Proc. 5th N. Amer. Rock Mechanics Symp., Toronto, Canada, July 2002.

Medley, E.W., 2004; "Observations on Tortuous Failure Surfaces in Bimrocks", *Felsbau, J. of Engineering Geology, Geomechanics and Tunnelling*. 22 (5/2004): pp. 35-43.

Medley, E.W. and Lindquist, E.S., 1995; "The engineering significance of the scale-independence of some Franciscan melanges in California", USA: in Proc. 35th US Rock Mechanics Symp; A.A. Balkema, Rotterdam.

Medley, E.W., and Sanz. P.R., 2004; "Characterization of Bimrocks (Rock/Soil Mixtures) With Application to Slope Stability Problems", in Schubert, W. (ed), Proc. Eurock 2004 and 53rd Geomechanics Colloquium, Salzburg, Austria, Oct 2004).

Raymond, L.A., 1984; "Classification of melanges: in Melanges: Their nature, origin and significance"; Special Publication 228, Geol. Soc. of America, Boulder, Colorado; p.7-20.

Moritz, B., K. Grossaeur, and W. Schubert, 2004; "Short Term Prediction of System Behaviour of Shallow Tunnels in Heterogeneous Ground", *Felsbau, J. of Engineering Geology, Geomechanics and Tunnelling*. 22 (5/2004), pp. 35-43: pp. 44-53.

Riedmueller, G and W. Schubert, 2002; Tunnels through fault rocks and tectonic melanges – a Short Course for engineering geologists and geotechnical engineers", (presentations and field trip guide), San Francisco Sections of the Association of Engineering Geologists and American Society for Civil Engineers, May 31-June 1, 2002, Oakland, California.

Riedmüller, G., F.J. Brosch, K. Klima and E.W. Medley, 2001; "Engineering Geological Characterization of Brittle Faults and Classification of Fault Rocks," Felsbau Rock and Soil Engineering-Journal for Engineering Geology, Geomechanics and Tunneling, Vol. 19, No. 4, pp. 13-18, July 2001.

Riedmüller, G., F.J. Brosch, K. Klima and E.W. Medley, 2004; "Engineering Geological Classification of Fault Rocks", Poster at Eurock 2004 and 53rd Geomechanics Colloquium, Salzburg, Austria, October 2004.

Sönmez, H., Gokceoglu, C., Tuncay, E., Medley, E.W. and Nefeslioglu, H.A, 2004; "Relationship Between Volumetric Block Proportions and Overall UCS of a Volcanic Bimrock", Felsbau, J. of Engineering Geology, Geomechanics and Tunnelling. v. 22 no. 5 (5/2004); pp 27-34.

Sönmez, H.A, C. Gokceoglu, E.W. Medley, E. Tuncay, and H.A. Nefeslioglu, 2006a; "Estimating the Uniaxial Compressive Strength of a Volcanic Bimrock", *International Journal of Rock Mechanics & Mining Sciences*, vol. 43 (2006) 554–561.

Sönmez, H., H., Altinsoy, C. Gokceoglu, and E.W. Medley, **2006b**; "Considerations in developing an empirical strength criterion for bimrocks"; in Proc. 4th Asian Rock Mechanics Symposium, Nov 6 -10 2006, Singapore.

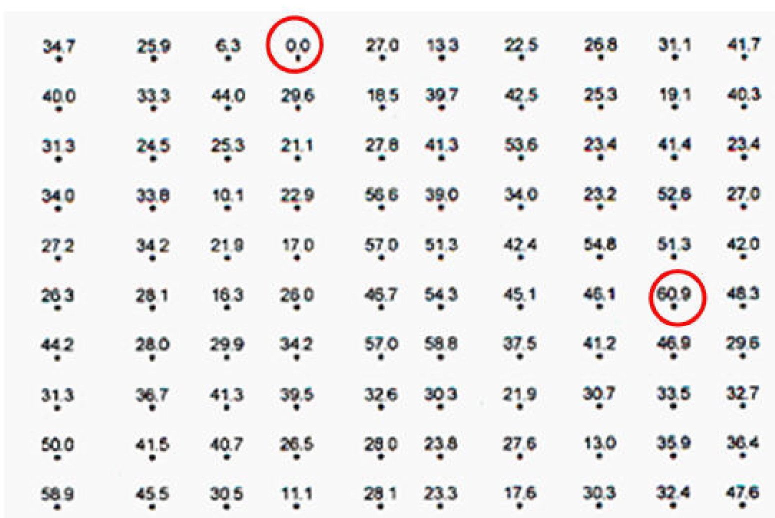
Wakabayashi, J., and E.W. Medley, 2004: "Geological characterization of melanges for geopractitioners", *Feldsbau, J. of Engineering Geology, Geomechanics and Tunnelling*. 22 (5/2004); pp. 10-18.

Weibel, E.R., 1980; "Stereological methods," Volume 2: Theoretical Foundations, Academic Press, New York, 340 p.

ERRATA- Article 1

return to text: click here

Figure 8: Franciscan Complex melange, northern California. Note shearing in "matrix" adjacent large headland block with blocks oriented sub-parallel to shearing. Block sizes range between tens of meters and meters. Detail shows "matrix" in at circled area also has block-in-matrix fabric at scale of 3.1m long bar. (Photo: E. Medley).



return to text: click here

Figure 10: Plan view of an array of 100 linear block proportions ranging between 0% and 61% measured for a physical model bimrock with actual volumetric block proportion of 32%. The range in spatial variability is indicated by the circled values (After Medley, 1997).