



## Bibliography

- Aki, K., 1957. Space and time spectra of stationary stochastic waves, with special reference to microtremors. *Bull. Earthquake Res. Inst.* 35, 415–456.
- Anderson, J.G., Lee, Y., Zeng, Y., Day, S., 1996. Control of strong motion by the upper 30 meters. *Bull. Seismol. Soc. Am.* 86, 1749–1759.
- Anggraini. A., 2013. The 26<sup>th</sup> May 2006 Yogyakarta earthquake, aftershocks and interactions, PhD thesis, Universitat Potsdam.
- Atkinson, G. M., and Silva, W., 2000. Stochastic modeling of California ground motions, *Bulletin of the Seismological Society of America*, 90, 2, pp. 255–274.
- Bard, P.-Y., and SESAME participants, 2004. The SESAME project: an overview and main results. *Proceedings of the 13th World Conference in Earthquake Engineering*, Vancouver, Paper # 2207
- Bird, P., 2003. An updated digital model of plate boundaries: Geochemistry, Geophysics, Geosystems, Vol.4, No (3), 1027 ([http://element.ess.ucla.edu/publications/2003\\_PB\\_2002/2001\\_GC\\_000252.pdf](http://element.ess.ucla.edu/publications/2003_PB_2002/2001_GC_000252.pdf))
- Borcherdt, R.D., 1994. Estimates of site-dependent response spectra for design. *Earthquake Spectra* 10, 617–653.
- Bolt, B. B., 1976. Nuclear Explosions and Earthquakes: The Parted Veil. San Francisco, CA: W.H. Freeman and Company.
- Boore, D. M., 1983. Stochastic simulation of high-frequency ground motions based on seismological models of the radiated spectra. *Bull Seismol Soc Am* 73:1865–1894.
- Boore, D. M., 2003. Simulation of ground motion using the stochastic method. *Pure Appl Geophys* 160:635–676.
- Brocher, T.M ., 2005. Empirical relations between elastic wavespeeds and density in the Earth's crust. *Bull Seismol Soc Am* 95:2081–2092.
- Building Seismic Safety Council, 2003. NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures, Part: Provisions, FEMA 450. Federal Emergency Management Agency, Washington, D. C.



Computers and Structures, Inc., “SAP2000 – Structural Analysis Program,” version 20, copyright 1984 – 2000.

Crampin, S., Bath, M.1965. Higher modes of seismic surface waves: mode separation. *Geophys. J. Int.* 10, 81–92. <http://dx.doi.org/10.1111/j.1365-246X.1965.tb03053.x>.

Fathani, T.F., Adi,A.D., Pramumijoyo, S., and Karnawati, D. 2008. The determination of Peak Ground Acceleration at Bantul Regency,Yogyakarta Province, Indonesia, The Yogyakarta Earthquake of May 27, 2006, Star publishing company,Canada, pp. 12-1 – 12-15.

FEMA 450-1. 2003. NEHRP recommended provisions for seismic regulations of new buildings and other structures. FEMA, Washington, DC.

Fookes, P.G., Lee, E.M., Griffiths, J.S. (Eds.), 2007. Engineering geomorphology: Theory and Practice. CRC Press, New York.

Foti, S., Lai, C.G., Rix, G.J., Strobbia, C., 2015. Surface wave methods for near-surface site characterization, CRC Press, Taylor & Francis Group.

Fripp,R., 2015. Surface wave analysis for near surface applications, Elsevier (<http://store.elsevier.com>)

Fukuoka, K., Ehara, S., Fujimitsu, Y., Harmoko, U., Setyawan, A., Setiadji, L.D., Harijoko, A., Pramumijoyo, S., Setiadi, Y., and Wahyudi. 2008. Interpretation of the 27 May 2006 Yogyakarta Earthquake hypocenter and subsurface structure deduced from the aftershock and gravity data, The Yogyakarta Earthquake of May 27, 2006, Star publishing company,Canada, pp.5-1 – 5-10.

Gardner GHF, Gardner LW, Gregory AR .1974. Formation velocity and density – the diagnostic basics for stratigraphic traps. *Geophysics* 39:770–780.

Giardini, D., Donato, M.di., and Boschi, E., 1997. Calibration of magnitude scales for Earthquake of the Mediterranean, *Journal of Seismology*, Vol.1, 161-180.

Gupta, A.K. 1992. Response spectrum method in seismic analysis and design of structures, CRC Press.INC.

Hall, R. 1995. Plate Tectonic Reconstructions of the Indonesia Region, Proceeding Indonesia Petroleum Association, Twenty fourth Annual Convention.



- Hall, R. 2002. Cenozoic geological and plate tectonic evolution of SE Asia and the SW Pacific: computer based reconstructions, model and animations. *Journal of Asian Earth Sciences*, 20, 353–434.
- Hall, R., Clements, B., Smyth, H.R., Cottam, M.A. 2007. A New Interpretation of Java's structure, *Proceedings, Indonesian Petroleum Association, Thirty- First Annual Convention and Exhibition*.
- Hall, R., 2011. Australia –SE Asia collision: plate tectonics and crustal flow, *Geology Society London, Special Publications*-355, pp. 75 – 109.
- Hanks, T.C., McGuire, R.K., 1981. The character of high frequency strong ground motion. *Bull Seismol Soc Am* 71:2071–2095.
- Hanks, T.C., Kanamori, H., 1979. A moment magnitude scale, *Journal of Geophysical Research*, Vol.84, No.B5.
- Hamilton, W.H., 1979. Tectonics of the Indonesian region. *U.S. Geological Survey Professional Paper*, 1078, 345 pp.
- Horike, M., 1985. Inversion of phase velocity of long period microtremors to the S-wave velocity structure down to the basement in urbanized areas. *J. Phys. Earth* 33, 59–96. <http://dx.doi.org/10.4294/jpe1952.33.59>.
- Husein, S., Pramumijoyo, S., Thant, M., Naing, T., and Murjaya, J., 2008. A short Note on the seismic history of Yogyakarta prior to the May 27, 2006 Earthquake, *The Yogyakarta Earthquake of May 27, 2006*, Star publishing company, Canada, pp. 3-1 – 3-7.
- <http://www.agisoft.com>
- <http://www.earthquake.usgs.gov>
- [http://iisee.kenken.go.jp/eqcat/strong\\_motion](http://iisee.kenken.go.jp/eqcat/strong_motion)
- IAEA.2015. Ground motion simulation based on fault rupture modelling for seismic hazard assessment in site evaluation for nuclear installations. International Atomic Energy Agency, Safety reports series, ISSN 1020–6450; No. 85.
- Irikura, K., 1986. Prediction of strong acceleration motions using empirical Green's function, *Proceedings of the 7th Japan Engineering Symposium*, 151-156.



Irikura, K., Miyake, H., Iwata, T., Kamae, K., Kawabe, H., & Dalguer, L. A. 2004.

Recipe for predicting strong ground motion from future large earthquake. In Proceedings of the 13th World Conference on Earthquake Engineering No. 1371.

Irikura, K., & Miyake, H., 2011. Recipe for Predicting Strong Ground Motion from Crustal Earthquake Scenarios. Pure and Applied Geophysics, 168, 85–104. doi:10.1007/s00024- 010-0150-9.

Irsyam, M., Sengara, W., Aldiamar, F., Widiyantoro, S., Triyoso, W., Natawidjaja, D.H., Kertapati, E., Meilano, I., Suhardjono., Asrurifak, M., Ridwan, m., 2010. Development of Seismic Hazards Maps of Indonesia for revision of hazard map in SNI 03-1726-2002.

Irsyam, M., Sengara, W., Aldiamar, F., Widiyantoro, S., Triyoso, W., Hilman, D., Kertapati, E., Meilano, I., Suhardjono, Asrurifak, M., Ridwan, M., Hutabarat, D., Sidi, I.J., and Merati, W., 2013. Development of seismic hazard and risk maps for new seismic building and Infrastructure codes in Indonesia, Proceeding the 6th Civil Engineering Conference in Asia Region, K-32 – K39.

Kagawa.T ., 2004. Developing a Stochastic Green's Function Method having more accuracy in long period range to be used in the Hybrid Method, Japan Association for Earthquake Engineering, Vol.4, No.(2), pp.21-32, 2004.

Kame,K., and Irikura, K., 1998. Rupture process of the 1995 Hyogo-ken Nanbu earthquake and simulation of near-source ground motion, Bull Seismol Soc Am 88, 400-412.

Karnawati, D., Husein, S., Pramumijoyo, S., Ratdomopurbo, A., Watanabe, K., and Anderson, R., 2008. Earthquake Microzonation and Hazard maps on Bantul Area, Yogyakarta, Indonesia, The Yogyakarta Earthquake of May 27, 2006, Star publishing company, Canada, pp. 8-1 – 8- 8.

Kawase, H., Nakamura, S., and Pramitasari, D., 2008. Strong Motion levels based on damage survey and site characteristics based on microtremors in the epicentral area, The Yogyakarta Earthquake of May 27, 2006, Star publishing company, Canada, pp.13-1 – 13-11.



- Kramer, S.L.1996. Geotechnical Earthquake Engineering, Prentice – Hall, New Jersey.
- Kuepper,G.J., 2006. EDM Report for 6.3 earthquake at Java, Indonesia-May 27, 2006.
- Kyaw, Z.L., Pramumijoyo, S., Husein. S., Fathani, T.F., and Kiyono, J., 2013. Ground motion in Yogyakarta City, Yogyakarta Special Province, Indonesia on densely microtremor observations and shear wave velocity J.SE Asian Appl.Geol., Jan- Jun 2013, Vol.5 (1), pp. 10-20.
- Kyaw, Z.L., Pramumijoyo, S., Husein. S., Fathani, T.F., and Kiyono, J., 2015. Seismic behaviors estimation of the shallow and deep Soil layers using microtremor recording and EGF technique in Yogyakarta City, central Java island, Procedia Earth and Planetary Science 12, pp. 31-46.
- Marliyani, G.I., 2016. Neotectonics of Java, Indonesia:Crustal Deformation in the Overriding Plate of an Orthogonal Subduction System, Dissertation.
- Milson, J., Masson,D., Nichols, G., Sikumbang, N., Dwiyanto, B., Parson, L., Kallagher, H., 1992. The Manokwari Trough and the western end of the New Guinea Trench, Tectonics, pp.145 -153.
- Minster, B.J.1. 978. Present day plate motions, Journal of geophysical research, Vol.83.No.B11.
- Miyake, H., Iwata, T., and Irikura, K., 2003, Source characterization for broadband ground-motion simulation: kinematic heterogeneous source model and strong motion generation area, Bull Seismol Soc Am 93, 2531–2545.
- Nakamura, Y., 1989. A Method for Dynamic Characteristics Estimation of Subsurface using Microtremor on the Ground Surface, Quarterly Report of RTRI, 30:1, 25-33.
- Nakamura, Y., 2008. On the H/V spectrum, the 14<sup>th</sup> world conference on earthquake engineering, Beijing, China.
- Naing, T., and Pramumijoyo, S., 2010. Analysis of microtremors for determination of site effects, Lambert Academic Publishing.
- National Standardization Agency, SNI 1726. Planning procedures for the earthquake resistance of building structure.



- Nazarian, S., Stokoe II, K.H., Hudson, W.R., 1983. Use of spectral analysis of surface waves method for determination of moduli and thicknesses of pavement systems: transport. Res. Rec. 930, 38–45.
- New Zealand Geotechnical Society., 2005. Field description of soil and rock, Book.
- Nogoshi, M. and Igarashi, T., 1970. On the propagation characteristics estimations of subsurface using microtremors on the ground surface. Journ. Seismol. Soc. Japan 23, 264-280.
- Nogoshi, M. and Igarashi, T., 1971. On the amplitude characteristics of microtremor (Part 2) (in Japanese with English abstract). Jour. Seism. Japan 24, 26-40.
- Nurwidiyanto, M.I., Kirbani, S.B., Sismanto., Waluyo., 2014. The subsurface modeling of Opak fault with inversion method of gravity data, Yogyakarta Region, International Journal of Basic and Applied Sciences IJBAS – IJENS Vol.14 (6).
- Nurwihastuti, D.W., Sartohahi, J., Mardiatno, D., Nehren, U., Restu., 2014. Understanding of earthquake damage pattern through geomorphological approach: A case study of 2006 earthquake in Bantul, Yogyakarta, Indonesia, word Journal of Engineering and Technology, Vol.2, pp. 61-70.
- Ohta. Y.,and Goto. N., 1978. Empirical shear wave velocity equations in terms of characteristic soil indexes, Earthquake engineering and structural dynamics, Vol.6,167-187.
- Park, C. B., Miller, R. D. & Xia, J., 1997. Summary report on surface-wave project at Kansas Geological Survey (KGS). [Open-file Report]. Lawrence, KS: Kansas Geological Survey.
- Park, C. B., Miller, R. D. & Xia, J., 1999. Multichannel analysis of surface waves (MASW). Geophysics, 64 (3), 800-808.
- Park, C. B., Miller, R. D. & Xia, J. 2001. Offset and resolution of dispersion curve in multichannel analysis of surface waves (MASW). Proceedings of the Symposium on the Application of Geophysics to Engineering and Environmental Problems (SAGEEP 2001), Denver, Colorado, SSM-4.



- Park, C. B., Miller, R. D., Xia, J. and Ivanov, J., 2007. Multichannel analysis of surface waves (MASW) - active and passive methods. *The Leading Edge*, 26 (1), 60-64.
- Pramumijoyo, S. 1991. Neotectonique et seismotectonique de la terminaison meridionale de la Grande faille de Sumatra et du Detroit de la Sond (Indonesie). Doctoral thesis, Universite de Paris-Sud, Orsay, France.
- Pramumijoyo, S. 2006. Community response to earthquake hazards, lesson learned from Yogyakarta Earthquake 2006.
- Pramumijoyo, S., and Sudarno, I., 2008. Surface cracking due to Yogyakarta Earthquake 2006, *The Yogyakarta Earthquake of May 27, 2006*, Star publishing company, Canada, pp. 6-1 – 6-5.
- Rahardjo, W., Sukandarrumidi., and Rosidi, H.M.D., 1995. Geological Map of the Jogjakarta sheet, Jawa. Scale 1: 100,000, Geological Research and Development Center, Bandung.
- Raper, J, and Maguire D. J. 1992. Design models and functionality in GIS. Computer & Geosciences, Pergamon Press, Vol. 18, No. 4, pp. 387-394
- Rosyidi, S.A., Lesmana, S.B., Wintolo, J., Chik, Z., and Taha, M.R., 2008. Geo-resistivity surveys for faults identification in Geotechnical damages area from Yogyakarta earthquake of May 27, 2006, the 14th world conference on earthquake engineering, Beijing, China.
- Satyarno, I., 2008. Some Practical Aspects in the post Yogyakarta Earthquake Reconstruction of Brick Masonry Houses, *The Yogyakarta Earthquake of May 27, 2006*, Star publishing company, Canada, pp.17-1 – 17-10.
- Setijadji, L.D., Barianto, D.H., Watanabe, K., Fukuoka, K., Ehara, S., Rahardjo, W., Sudarno, I., Shimoyama, S., Susilo, A., Itaya, T., 2008. Searching for the active fault of the Yogyakarta earthquake of 2006 using data integration on aftershocks, Cenozoic Geo- history, and Tectonic Geomorphology, *The Yogyakarta Earthquake of May 27, 2006*, Star publishing company, Canada, pp. 4 - 1 – 4 - 23.
- Snyder, N. P., Whipple, K. X., Tucker, G. E., and Merritts, D. J., 2003. Channel response to tectonic forcing: field analysis of stream morphology and



- hydrology in the Mendocino triple junction region, northern California. Geomorphology, 53(1), 97-127.
- Stewart, J.P., Chiou, S.J., Bray, J.D., Graves, R.w., Somerville, P.G., Abrahamson, N.A., 2001. Ground motion evaluation procedures for performance-based design, PEER Report No. 2001/09, Pacific Earthquake Engineering Research Center, Berkeley, CA.
- Surono., Toha dan.B., and Sudarno.I., 1992. Geological Map of the Surakarta sheet, Jawa. Scale 1: 100,000, Geological Research and Development Center, Bandung.
- Thant, M., Pramumijoyo, S., Kawase, H., Hendrayana, H., and Adi, A.D., 2008. Focal Mechanisms of Subduction Zone Earthquakes along the Java Trench: Preliminary Study of PSHA for Yogyakarta Region, Indonesia, Proceeding, 14th WCEE, Beijing, China.
- Thant, M., Pramumijoyo, S., Kawase, H., Hendrayana, H., and Adi, A.D., 2010. Evaluation of strong ground motion for Yogyakarta depression area, Indonesia, J.SE Asian Appl.Geol., May – Aug 2010, Vol.2 (2), pp 81 - 94.
- Theodulidis,N., Culterera,G., and Tento.A., 2004. Empirical evaluation of the horizontal to vertical spectral ratio technique results from the “SESAME” project, 13th world conference on Earthquake Engineering, Vancouver, B.C., Canada, Paper No.2323.
- Tsuji, T., Yamamoto, K., Matsuoka, T., Yamada, Y., Onishi, K., Bahar, A., meilano, I., and Abidin, H.Z., 2009. Earthquake fault of the 26 May 2006 Yogyakarta earthquake observed by SAR interferometry, Earth Planets space, 61,e 29 - e 32.
- Untung, M., Ujang, K., and Ruswandi, E., 1973. Gravity survey in the Yogyakarta-Wonosari Area, Central Java Publikasi Tenik Seri- Geofisika, No.3, GSI, Bandung.
- Van Bemmelen, R.W., 1949. The Geology of Indonesia, vol.1A, General Geology of Indonesia and Adjacent Archipelagoes, Government Printing Office, Martinus Nijhoff.



- Wagner.D., Rabbel.W., Luehr.B.-G., Wassermann.J., Walter.T.R., Kopp.H., Koulakov.I., Wittwer.A., Bohm.M., Asch.G., 2008. Seismic Structure of Central Java, The Yogyakarta Earthquake of May 27, 2006, Star publishing company, Canada, pp. 2-1 – 2-9.
- Walter, T.R., Wang, R., Luehr, B.- G ., Wassermann,J., Behr, Y., Parolai, S., Anggraini, A., Gunther, E., Sobiesiak, M., Grosser, H., Kletzel, H.-U. , Milkereit, C., Sri Brotopuspito, P.J.K., Harjadi, P., Zschau, J., 2008. The 26 May 2006 magnitude 6.4 Yogyakarta earthquake south of Mt. Merapi volcano: Did lahar deposits amplify ground shaking and thus lead to the disaster?, *Geochemistry, Geophysics, Geosystems, An Electronic Journal of the Earth Sciences*, Vol.9, No (5), 1525- 2027.
- Wells, D.L. and Coppersmith, K.J., 1994. New empirical relationships among magnitude, rupture length, rupture width, rupture area and surface displacement. *Bulletin of the Seismological Society of America*, 84(4), 974-1002.
- Wyss, M., and Brune, J.N., 1968. Seismic moment, Stress, and Source dimensions for earthquakes in the California-Nevada Region, *Journal of Geophysical Research*, Vol.73, No.14.
- Xia, J., Miller, R. D. & Park, C. B. 1999. Estimation of near-surface shear-wave velocity by inversion of Rayleigh waves. *Geophysics*, 64 (3), 691-700.
- Xia, J., Miller, R. D., Park, C. B. & Ivanov, J. 2000. Construction of 2-D vertical shear-wave velocity field by the multichannel analysis of surface waves technique. Proceeding of the Symposium of the Application of Geophysics to Engineering Environmental Problems (SAGEEP 2000) Arlington, VA., February 20-24, 1197-1206.
- Xia, J., Miller, R. D., Park, C. B., Hunter, J. A., Harris, J. B. & Ivanov, J. 2002. Comparing shear-wave velocity profiles from multichannel analysis of surface wave with borehole measurements. *Soil Dynamics and Earthquake Engineering*, 22 (3), 181-190.
- Xia, J., Miller R. D., Park C. B. & Tian G. 2003. Inversion of high frequency surface waves with fundamental and higher modes. *Journal of Applied Geophysics*, 52, 45-57.



## Curricular Vitae



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## THE MORPHOLOGY OF OPAK FAULT SYSTEM AND ITS IMPLICATION TO EARTHQUAKE HAZARD OF SURROUNDING AREA BASED ON 2006 YOGYAKARTA EARTHQUAKE DATA

UNIVERSITAS  
GADJAH MADA

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### Education

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