

## Curriculum Vita:

### Seiji Nakagawa, Ph.D.

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#### Education

Ph.D. Materials Sciences and Mineral Engineering, University of California at Berkeley, 1998, GPA 4.0

M.E. Civil Engineering, Kyoto University, Japan, 1993, GPA 3.7

B.E. Civil Engineering, Kyoto University, Japan, 1991, GPA 3.8

#### Employment History

2001 - Present	Research Scientist, Energy Geosciences Division, Earth and Environmental Sciences Area, Lawrence Berkeley National Laboratory
1998 - 2001	Post-doctoral Researcher, Lawrence Berkeley National Laboratory
1995 - 1998	Graduate Student Research Assistant, Lawrence Berkeley National Laboratory
1993 - 1995	Graduate Student Researcher, University of California at Berkeley

#### Professional Society

Member, American Geophysical Union

Member, American Rock mechanics Association

#### Scholarship and Awards

Best Research Presentation Award, BES Annual Symposium on Geoscience, Maryland, 2012.

Recognition among the top 25 papers presented at 70th Annual meeting for Society of Exploration Geophysicists, 2001

Neville G.W.Cook Award, presented by US National Committee for Rock Mechanics, 2000

Outstanding Student Presentation Award in Seismology, Fall Annual Meeting of American Geophysical Union, 1998

Jane Lewis Fellowship 1996-1997

Ishizaka Scholarship 1993-1995

Haraguchi Fellowship 1991-1993

## Journal publications

### • Refereed Journals (published and accepted):

- Dou, S., S. Nakagawa, D. Dreger, and J. Ajo-Franklin. 2017. An effective-medium model for P-wave velocities of saturated, unconsolidated saline permafrost, *Geophysics*, **82**, EN33-EN50, doi:10.1190/GEO2016-0474.1.
- Dou, S., S. Nakagawa, D. Dreger, and J. Ajo-Franklin. 2016. A rock-physics investigation of unconsolidated saline permafrost: P-wave properties from laboratory ultrasonic measurements, *Geophysics*, **81**, WA233-WA245, doi:10.1190/geo2015-0176.1.
- Nakagawa, S., S. Nakashima, and V.A. Korneev. 2015. Laboratory measurements of guided-wave propagation within a fluid-saturated fracture, *Geophys. Prospect.*, **64**, 143-156.
- Nakagawa, S. and Korneev, V.A. 2014. Effect of fracture compliance on wave propagation within a fluid-filled fracture, *J. Acoust. Soc. Am.*, **135**(6), 3186-3197/
- Korneev, V.A., L. Danilovskaya, S. Nakagawa, and G. Moridis. 2014. Krauklis wave in a trilayer, *Geophysics*, **79**, (4), L33-L39, Doi 10.1190/Geo2013-0216.1
- Nakagawa, S., T.J. Kneafsey, T.M. Daley, B.M. Freifeld, and E.V. Rees. 2013. Laboratory seismic monitoring of supercritical CO<sub>2</sub> flooding in sandstone cores using the Split Hopkinson Resonant Bar technique with concurrent x-ray CT imaging, *Geophys. Prospect.*, **61**, 254-269.
- Nakagawa, S. 2011. Split Hopkinson resonant bar test for sonic-frequency acoustic velocity and attenuation measurements of small, isotropic geological samples, *Rev. Sci. Instrum.*, **82**, 044901, doi:10.1063/1.3579501.
- Nihei, K. T., S. Nakagawa, F. Reverdy, L. R. Myer, L. Duranti, and G. Ball. 2011. Phased array compaction cell for measurement of the transversely isotropic elastic properties of compacting sediments, *Geophysics*, **76**, 1–11, doi:10.1190/1.3567160.
- Knight, R., L. J. Pyrak-Nolte, L. D. Slater, E. A. Atekwana, A. L. Endres, J. Geller, D. Lesmes, S. Nakagawa, A. Revil, M. M. Sharma, and C. Straley. 2010. Geophysics at the interface: Response of geophysical properties to solid-fluid, fluid-fluid, and solid-solid interfaces, *Rev. Geophys.*, **48**, 4002-4031, doi:10.1029/2007RG000242.
- Berryman, J. and S. Nakagawa. 2010. Inverse Problem in Anisotropic Poroelasticity: Drained Constants from Undrained Ultrasound Measurements, *J. Acoust. Soc. Am.*, **127**, 720-729
- Kowalsky, M., S. Nakagawa, J. Moridis. 2010. Feasibility of Monitoring Gas Hydrate Production with Time-Lapse VSP, Accepted for publication in *SPE Journal* (SPE 132508)
- Nakagawa, S. 2008. Poroelastic modeling of fracture-seismic wave interaction, *Int. J. of the JCRM*, **4**(2), 5-14.
- Nakagawa, S. and M.A.Schoenberg, 2007, Poroelastic modeling of seismic boundary conditions across a fracture, *J. Acoust. Soc. Am*, **122**(2), 831-847.
- Lonardelli, I., H.-R. Wenk, H. Franz, K. Nihei and S. Nakagawa. 2007. Texture analysis and elastic anisotropy of illite clay, *Geophysics*, **72**, E69-75.
- Nakagawa, S. and T. M. Daley, 2006, Modeling wave generation by borehole orbital vibrator source, *Geophysics*, **71**, F1-F11, DOI 10.1190/1.2168008
- Wu, Chunling, J.M. Harris, K.T. Nihei, and S. Nakagawa, 2005, 2-D finite-difference seismic modeling of an open fluid-filled fracture: comparison of thin-layer and linear-slip models, *Geophysics*, **70**(4), P.T57-T62, DOI 10.1190/1.1988187
- Watanabe, T., K.T. Nihei, S. Nakagawa, and L. R. Myer, 2004, Viscoacoustic wave form inversion of transmission data for velocity and attenuation, *J. Acoust. Soc. Am.*, **115**(6), 3059-3067.
- Nakagawa, S., K. T. Nihei, and L. R. Myer, 2004, Plane wave solution for elastic wave scattering by a heterogeneous fracture, *J. Acoust. Soc. Am.*, **115**(6), 2761-2773.
- Bessenger, B., N.G.W. Cook, L.R. Myer, S. Nakagawa, K.T. Nihei, P.H. Benito, and R. Suarez-Rivera, 2003, The role of compressive stresses in jointing on Vancouver Island, British Columbia, *Journal of Structural Geology*, **25**(6), 983-1000.
- Nakagawa, S., K. T. Nihei, and L. R. Myer, 2003, 3-D elastic wave scattering by a layer containing vertical periodic fractures, *J. Acoust. Soc. Am*, **113**(6), 3012-3023.
- Nakagawa, S., K. T. Nihei, and L. R. Myer, 2002, Elastic wave propagation along a set of parallel fractures, *Geophys. Res. Lett*, AGU DOI: 10.1029/2002GL014925.
- Nakagawa, S., K. T. Nihei, and L. R. Myer, 2000, Shear induced conversion of seismic waves across single fractures, *Int. J. Rock Mech. Min. Sci. & Geomech. Abstr.*, **37**(1-2), 203-218.

- Nihei, K. T., N. G. W. Cook, S. Nakagawa, L.R. Myer, and B. Hilbert, 2000, Frictional effects on the volumetric strain of sandstone, *Int. J. Rock Mech. Min. Sci. & Geomech. Abstr.*, **37**(1-2), 121-132/
- Nakagawa, S., 2000, Stop-Pass Behavior of Acoustic Waves in a 1-D Fractured System, *J. Acoust. Soc. Am.*, **107**(1), 40-50.
- Terado, Y., S. Nakagawa, S. Yoneda, I. Shiozaki, Y. Ohnishi, and K. Nakagawa, 1998, Open-cut survey on a heavily fractured rock mass after grout injection, *J. Geotech. Eng.*, JSCE, **589**, 55-66.
- Ohnishi, Y., S. Nakagawa, and M. Tanaka, 1994, Methods of estimation for geometric distributions of rock joints, *J. Geotech. Eng.*, JSCE, **499**, 59-68.
- Ohnishi, Y. and S. Nakagawa, 1993, A method for grouping and probabilistic modeling of joint orientations (technical note), *J. Geotech. Eng.*, JSCE, **463**, 173-176.
- Note: *J. Geotech. Eng.*, JSCE is an archival refereed journal published by the Japan Society of Civil Engineers.

#### • Refereed Conference Proceedings and Expanded Abstracts

- Nakagawa, S. 2017. Laboratory visualization of hydraulic fracture propagation induced by variable-rate fluid injection within analogue rock samples containing preexisting fractures, Paper#17-928, accepted for publication in proceedings for 51th US Rock Mechanics Symposium/ARMA Meeting, San Francisco, June 25-28.
- Nakagawa, S., S.R. Pride, and V.A. Korneev. 2015. Extremely slow, dispersive seismic wave propagation within a fluid-filled fracture, and its electrokinetic effects, Paper #651, 49<sup>th</sup> US Rock Mechanics Symposium/ARMA Meeting, San Francisco, June 28-July 1.
- Nakagawa, S. 2013. Low-frequency (<100 Hz) dynamic fracture compliance measurements in the laboratory, Paper#13-343, 47<sup>th</sup> US Rock Mechanics Symposium/ARMA Meeting, San Francisco.
- Nakagawa, S. and L.R.Myer. 2009. Fracture permeability and seismic wave scattering – Poroelastic linear-slip interface model for heterogeneous fractures, In Expanded Abstract, Annual Meeting of the Society of Exploration Geophysicists, Houston.
- Nakagawa, S. and R.W. Ewy, 2008, Shaped-core uniaxial compression test for studying borehole breakout in rocks, In Proceedings for American Rock Mechanics Association Meeting, Paper No.158, San Francisco, July.
- Nakagawa, S., 2008, Shear stress monitoring on a rough fracture using seismic wave scattering, In Proceedings for American Rock Mechanics Association Meeting, Paper No. 159, San Francisco, July.
- Nakagawa, S., T. J. Kneafsey, and G. J. Moridis, 2008, Mechanical strength and seismic property measurements of hydrate-bearing sediments (HBS) during hydrate formation and loading Tests, OTC 19559, Proceedings, Offshore Technology Conference, Houston, May 5-8.
- Kowalsky, M.B., S. Nakagawa, and G. Moridis, 2008, Feasibility of monitoring gas hydrate production with geophysical methods, Paper OTC-19489-PP presented at the Offshore Technology Conference, Houston, Texas, May 5-8.
- Sherlock, D., K.T. Nihei, S. Nakagawa, and L. Duranti, 2007, Stress-induced anisotropy measurements in unconsolidated sand using a phased-array uniaxial compaction cell, In Expanded Abstract, Annual Meeting of the Society of Exploration Geophysicists, San Antonio.
- Sherlock, D., K. Nihei, S. Nakagawa, and L. Duranti, 2007, Laboratory measurements of stress-induced velocity anisotropy in unconsolidated sands, submitted to 19<sup>th</sup> Geophysical Conference and Exhibition, Perth, Western Australia, 18-22 November.
- Schoenberg, M.A. and S. Nakagawa, 2006. Poroelastic modeling of seismic boundary conditions across a fracture, Extended Abstract, 76th annual meeting of Society of Exploration Geophysics, 2991-2995.
- Toomey, A. C. and S. Nakagawa, 2003, Seismic monitoring of shear stress on fractures/faults, Society of Exploration Geophysicists 73rd Annual International Meeting & Exposition.
- Nakagawa, S., T. M. Daley, and E.L. Majer, 2003, Waves generated by borehole orbital vibrator source, Extended Abstract, 73rd annual meeting of Society of Exploration Geophysics, 2247-2250.
- Majer, M.L., J. H. Queen, T. M. Daley, J. Murphy, M. Fortuna, H.Lynn, R. Coates, P. Eike, J.Sinton, D. Cox, L.Myer, K.Nihei, and S. Nakagawa, 2002, Scaling between logs, single well, VSP and surface seismic for fracture quantification in naturally fractured gas reservoirs, Extended Abstract, 72nd annual meeting of Society of Exploration Geophysics, Salt Lake City, 2381-2384.

- Nakagawa, S., K. T. Nihei, and L. R. Myer, 2002, Numerical simulation of 3D elastic wave scattering off a layer containing parallel periodic fractures, Extended Abstract, 72nd annual meeting of Society of Exploration Geophysics, 1967-1970.
- Nihei, K.T., S. Nakagawa, L.R. Myer, and E.L. Majer, 2002, Finite difference modeling of seismic wave interactions with discrete, finite fractures, Extended Abstract, 72nd annual meeting of Society of Exploration Geophysics, Salt Lake City, 1963-1966.
- Watanabe, T., K.T.Nihei, S. Nakagawa, and L.R. Myer, 2002, Imaging of crosshole laboratory data using visco-acoustic waveform inversion and reverse-time imaging, Extended Abstract, 72nd annual meeting of Society of Exploration Geophysics, Salt Lake City, 870-873.
- Nihei, K.T., S. Nakagawa, and L.R.Myer, 2001, Fracture imaging with converted elastic waves, 38th U.S. Rock Mech. Symp., Washington, DC, 1305-1311.
- Nakagawa, S. and L.R.Myer, 2001, Mechanical and acoustic properties of weakly cemented granular rocks, 38th U.S. Rock Mech. Symp., Washington, DC, 3-10.
- Liu, Z., J.W.Rector, K.T.Nihei, L.Tomutsa, L.R.Myer, and S. Nakagawa, 2001, 38th U.S.Rock Mech. Symp., Washington, DC, 141-145.
- Schoernberg, M.A. and S. Nakagawa, 2001, Acoustic Behavior of fractures under static stress, Extended Abstract, paper No.P-098, 63rd annual meeting of European Association of geoscientists and engineers, Amsterdam.
- Myer, L.R., S. Nakagawa, and K.T.Nihei, 2001, Discrete and equivalent medium modeling of fractures, Extended Abstract, 5th International Symposium of Society of Exploration Geophysics of Japan.
- Nakagawa, S., K. T. Nihei, and L. R. Myer, 2000, Effect of shear stress on the scattering of elastic waves across fractures, Extended Abstract, 70th annual meeting of Society of Exploration Geophysics, 2353-2356.
- Nihei, K. T., S. Nakagawa and L. R. Myer, 2000, VSP fracture imaging with elastic reverse-time migration, Extended Abstract, 70th annual meeting of Society of Exploration Geophysics, 1748-1751.
- Nakagawa, S., K. T. Nihei, and L. R. Myer, 1999, Frequency-dependent acoustic anisotropy in fractured rock, *9th Congress of International Society of Rock Mechanics*.
- Nakagawa, S., D. L. Hopkins, S. Gentier, and J. Riss, 1999, Hydromechanical behavior of fractures in shear: implications for seismic imaging, *9th Congress of International Society of Rock Mechanics*.
- Neau, G., D. L. Hopkins, S. Nakagawa, and K. T. Nihei, 1999, Complications of using resonance-frequency shifts to detect defective joints, *Review of Progress in Quantitative Nondestructive Evaluation*, **19**.
- Nihei, K.T., S. Nakagawa, D.L. Hopkins, 1999, Defect detection in bonded structures using the reverberant wavefield, To appear in *Review of Progress in Quantitative Nondestructive Evaluation*, **18**.
- Türler, D., D. L. Hopkins, S. Nakagawa, A. Valente, and K. T. Nihei. 1999. Thermographic and acoustic imaging of spot-welded and weld-bonded joints, To appear in *Review of Progress in Quantitative Nondestructive Evaluation*, **18**.
- Türler, D., D. L. Hopkins, S. Nakagawa, A. Valente, and K. T. Nihei, 1999, Nondestructive evaluation of spot-welded and weld-bonded joints using acoustic and thermographic imaging techniques, To appear in *the Society of Automotive Engineers*.
- Yi, W., S. Nakagawa, K. T. Nihei, J. W. Rector, L. R. Myer, and N. G. W. Cook, 1998, Numerical investigation of fracture channel waves, Extended Abstract, 68th annual meeting of Society of Exploration Geophysics, 1628-1631.
- Hopkins, D. L., S. Nakagawa, K.T. Nihei, and D. Turler, 1998, Imaging flaws in adhesive joints using acoustic techniques and infrared thermography, In *Review of Progress in Quantitative Nondestructive Evaluation*, **17**, 1397-1394.
- Myer, L.R., K.T. Nihei, and S. Nakagawa, 1998, Dynamic properties of interfaces, *Damage and Interfaces*, Proc. 1st Int. Conf., H.P. Rossmannith (ed), Balkema Publishers, Rotterdam.
- Yi, W., S. Nakagawa, K. T. Nihei, J. W. Rector, L. R. Myer, and N. G. W. Cook. 1997. Numerical investigation of fracture induced seismic anisotropy, Extended Abstract, 67th annual meeting of Society of Exploration Geophysics, 960-963.
- Yi, W., K.T. Nihei, J.W. Rector, S. Nakagawa, L.R. Myer, and N.G.W. Cook, 1997, Frequency dependent seismic anisotropy in fractured rock, *Int. J. Rock Mech. & Min. Sci.*, Vol. 34 (3-4), Paper No. 349.
- Nakagawa, S., N. G. W. Cook, K. T. Nihei, and L. R. Myer, 1995, Laboratory observation of seismic waves in heterogeneous geomaterials, Proc. 35th U. S. Symposium on Rock Mechanics, 183-187.

• **Refereed Abstracts:**

- Nakagawa, S. and T.J. Kneafsey. 2016. Laboratory visualization and acoustic emission monitoring of hydraulic fracturing in a complex, fractured medium, Paper #33-7, Geological Society of America *Abstracts with Programs.*, Vol. 48, No. 7, doi: 10.1130/abs/2016AM-284155.
- Dobson, P.F., C.M. Oldenburg, T.M. Daley, J.T. Birkholzer, P.J. Cook, J. Ajo-Franklin, J. Rutqvist, D.L. Siler, T.J. Kneafsey, S. Nakagawa, Y. Wu, Y. Guglielmi, C. Ulrich, H.F. Wang, B.C. Haimson, S. Niroki, P. Vigilante, W.M. Roggenthen, T.W. Doe, M.Y. Lee, E.D. Mattson, H. Huang, T.J. Johnson, J.P. Morris, J.A. White, P.A. Johnson, D.D. Coblenz, and J. Heise. 2016. The kisMET (Permeability [K] and induced seismicity Management for Energy Technologies) Project—An underground field laboratory for investigating the relations between natural and induced fractures, stress field, and rock fabric, Paper # 4-9, Geological Society of America *Abstracts with Programs.* Vol. 48, No. 7 doi: 10.1130/abs/2016AM-287681
- Nakagawa, S., T. Kneafsey, and S. Borglin. 2015, Laboratory Visualization of Hydraulic Fracture Propagation and Interaction with a Network of Preexisting Fractures, Am. Geophys. Union, 2015AGUFMMR41A2615N.
- Kneafsey, T.J. and S. Nakagawa. Using combined X-ray computed tomography and acoustic resonance to understand supercritical CO<sub>2</sub> behavior in fractured sandstone, Am. Geophys. Union, 2015AGUFM.H43L.01K.
- Nakagawa, S., T.J. Kneafsey, C. Chang, and E. Harper. 2013. Laboratory mid-frequency (Kilohertz) range seismic property measurements and X-ray CT imaging of fractured sandstone cores during supercritical CO<sub>2</sub> injection, Am. Geophys. Union, 2014AGUFM.S34A.03N.
- Nakashima, S., T.J. Kneafsey, S. Nakagawa, and E.J. Harper. 2013. Laboratory seismic monitoring and X-ray CT imaging of supercritical CO<sub>2</sub> injection in reservoir sand: WESTCARB King Island Project, Am. Geophys. Union, 2013AGUFM.S33C2434N.
- Nakagawa, S., K.T. Nihei and L.R. Myer, 2001, Frequency-dependent azimuthal anisotropy of seismic reflectivity from a layer with discrete fractures, *Eos, Trans. Am. Geophys. Union*, **82**(47), F861.
- Watanabe, T., K.T. Nihei, S. Nakagawa, L.R. Myer, 2001, Frequency-domain visco-acoustic full waveform inversion of laboratory data, *Eos, Trans. Am. Geophys. Union*, **82**(47), F862.
- Suarez-Rivera, R., S.M. Willson, S. Nakagawa and O. Magnar-Ness, 2001, Frequency scaling for evaluation of shale and mudstone properties from acoustic velocities, *Eos, Trans. Am. Geophys. Union*, **82**(47), F1192.
- Myer, L.R., S. Nakagawa, and R.W. Zimmerman, 2000, Laboratory measurements of the mechanical and seismic properties of weakly-cemented artificial sandstones, *Eos, Trans. Am. Geophys. Union*, **81**(46), F1186.
- Nakagawa, S., K.T. Nihei, and L.R. Myer, 1999, Amplitude anisotropy of seismic wave propagation in a medium containing parallel infinite fractures, *Eos, Trans. Am. Geophys. Union*, **80**(46), F624.
- Myer, L.R., S. Nakagawa, B.A. Bessinger, 1999, Role of local dilatation in formation of compaction bands, *Eos, Trans. Am. Geophys. Union*, **79**(45), F1067.
- Nakagawa, S., K.T. Nihei, and L.R. Myer, 1998, Stop-pass behavior of seismic waves in fractured rock, *Eos, Trans. Am. Geophys. Union*, **79**(45), F624.
- Nakagawa, S., K.T. Nihei, and L.R. Myer. 1997, Shear-induced conversions of seismic waves normally incident on a fracture, *Eos, Trans. Am. Geophys. Union*, **78**(46), F426.
- Kowalsky, M., S. Nakagawa, K.T. Nihei and L.R. Myer, 1997, Acoustic properties of poorly consolidated sediments during consolidation, *Eos, Trans. Am. Geophys. Union*, **78**(46), F678.
- Nakagawa, S., N.G.W. Cook, K.T. Nihei, and L.R. Myer, 1996, Resonance characterization of anisotropy in rock, *Eos, Trans. Am. Geophys. Union*, **77**(46), F695.

• **Workshop Papers:**

- Nakagawa, S., 2008, Poroelastic modeling of fracture-seismic wave interaction, Application of Geophysics to Rock Engineering, ARMA conference, June 29, San Francisco.
- Nihei, K.T., G.J. Ball, F. Reverdy, S. Nakagawa, and L.R. Myer, 2006. Phased array compaction cell for measuring the anisotropic elastic properties of compacting clay-rich sediments (invited), Proc. 12<sup>th</sup> Int. Workshop on Seismic Anisotropy, Beijing.

- Schoenberg, M. A. and S. Nakagawa, 2006, Soft layers, fractures, and anisotropy, EAGE Workshop, Vienna, June 12-15.
- Schoenberg M. A. and S. Nakagawa, 2002, Anisotropy of fractured rock under static shear stress, Proc. 10th Int. Workshop on Seismic Anisotropy, Tutzing,
- Schoenberg, M.A., K.T.Nihei, S. Nakagawa, and L.R.Myer, 2001, Scattering from reservoirs with discrete fractures, Extended Abstract, EAGE/SEG Research Workshop on Reservoir Rocks.
- Myer, L.R., S. Nakagawa, and K.T.Nihei, 2001, Seismic Wave Propagation in Weak Granular Rock, Proc. 3rd International Workshop on the Application of Geophysics to Rock and Soil Engineering.,
- Nakagawa, S., K. T. Nihei, and L. R. Myer, 1999, Dynamic Anisotropy of Rock Containing a Single Set of Multiple Parallel Fractures - Exact dispersion relations for 3-D body waves, generalized Rayleigh-Lamb waves, and generalized fracture interface waves, Proc. 2nd Int. Workshop on Appl. Geophys. to Rock Eng., 9th ISRM Congress, Paris.
- Nakagawa, S., M. Schoenberg, 2000, Elastic wave scattering by anisotropic fractures, Proc. 9th Int. Workshop on Seismic Anisotropy, Houston, 40-41.

• **Thesis:**

- Nakagawa, S., 1998, *Acoustic Resonance Characteristics of Rock and Concrete Containing Fractures*, Ph D Thesis, University of California at Berkeley.
- Nakagawa, S., 1993, *Characterization of Rock Joint Statistics from Geological Data and its Application*, ME Thesis, Kyoto University (Japan).