# Main Set of References

Aster, R.C., Borchers, B., and Thurber, C.H., 2005, Parameter estimation and inverse problems: Amsterdam, Elsevier Academic Press, International Geophysics Series, v. 90, 301 p.

Banta, E.R., Poeter, E.P., Doherty, J.E., and Hill, M.C., 2006, JUPITER: Joint Universal Parameter IdenTification and Evaluation of Reliability—An application programming interface (API) for model analysis: U.S. Geological Survey Techniques and Methods, book 6, chap. E1, 268 p.

Cardiff, M., and Kitanidis, P.K., 2009, Bayesian inversion for facies detection—An extensible level set framework: Water Resources Research, v. 45, W10416, doi:10.1029/2008wr007675.

Cardiff, M., Barrash, W., and Kitanidis, P.K., 2012, A field proof-of-concept of aquifer imaging using 3-D transient hydraulic tomography with modular, temporarily-emplaced equipment: Water Resources Research, v. 48, no. 5, W05531, doi:10.1029/2011WR011704.

Casella, G., 1985, An introduction to empirical Bayes data-analysis: American Statistician, v. 39, no. 2, p. 83–87, doi:10.2307/2682801.

Chamberlin, T.C., 1890, The method of multipleworking hypotheses: Science (Old Series), v. 15, no. 92.

Collinson, J.D., 1969, Sedimentology of Grindslow shales and Kinderscout grit—A deltaic complex in Namurian of Northern England: Journal of Sedimentary Petrology, v. 39, no. 1, p. 194–221.

Deutsch, C.V., and Journel, A.G., 1992, GSLIB—Geostatistical software library and user’s guide: New York, Oxford University Press, 340 p.

Doherty, J., 2010a, PEST, Model-independent parameter estimation—User manual (5th ed., with slight additions): Brisbane, Australia, Watermark Numerical Computing.

Doherty, J., 2010b, PEST, Model-independent parameter estimation—Addendum to user manual (5th ed.): Brisbane, Australia, Watermark Numerical Computing.

Draper, N.R., and Smith, H., 1966, Applied regression analysis: New York, Wiley, 407 p.

Fienen, M., Kitanidis, P., Watson, D., and Jardine, P., 2004, An application of Bayesian inverse methods to vertical deconvolution of hydraulic conductivity in a heterogeneous aquifer at Oak Ridge National Laboratory: Mathematical Geology, v. 36, no. 1, p. 101–126, doi:10.1023/B:MATG.0000016232.71993.bd.

Fienen, M., Luo, J., and Kitanidis, P., 2006, A Bayesian geostatistical transfer function approach to tracer test analysis: Water Resources Research, v. 42, no. 7, W07426, doi:10.1029/2005WR004576.

Fienen, M., Hunt, R., Krabbenhoft, D., and Clemo, T., 2009, Obtaining parsimonious hydraulic conductivity fields using head and transport observations—A Bayesian geostatistical parameter estimation approach: Water Resources Research, v. 45, W08405, doi:10.1029/2008wr007431.

Fienen, M.N., Clemo, T.M., and Kitanidis, P.K., 2008, An interactive Bayesian geostatistical inverse protocol for hydraulic tomography: Water Resources Research, v. 44, W00B01, doi:10.1029/2007WR006730.

Hill, M.C., 2006, The practical use of simplicity in developing ground water models: Ground Water, v. 44, no. 6, p. 775–781, doi:10.1111/j.1745-6584.2006.00227.x.

Hoeksema, R.J., and Kitanidis, P.K., 1984, An application of the geostatistical approach to the inverse problem in two-dimensional groundwater modeling: Water Resources Research, v. 20, no. 7, p. 1003–1020, doi:10.1029/WR020i007p01003.

Isaaks, E.H., and Srivastava, R.M., 1989, Applied geostatistics: Oxford, UK; New York; Oxford University Press, 561 p.

Jaynes, E.T., and Bretthorst, G.L., 2003, Probability theory—The logic of science: Cambridge, UK; New York; Cambridge University Press, 727 p.

Kitanidis, P.K., 1995, Quasi-linear geostatistical theory for inversing: Water Resources Research, v. 31, no. 10, p. 2411–2419, doi:10.1029/95WR01945.

Kitanidis, P.K., 1997, Introduction to geostatistics—Applications in hydrogeology: Cambridge, UK; New York; Cambridge University Press, 249 p.

Kitanidis, P.K., and Vomvoris, E.G., 1983, A geostatistical approach to the inverse problem in groundwater modeling (steady state) and one-dimensional simulations: Water Resources Research, v. 19, no. 3, p. 677–690, doi:10.1029/WR019i003p00677.

Li, W., Nowak, W., and Cirpka, O.A., 2005, Geostatistical inverse modeling of transient pumping tests using temporal moments of drawdown: Water Resources Research, v. 41, no. 8, p. 1–13, doi:10.1029/2004WR003874.

Li, W., Englert, A., Cirpka, O.A., Vanderborght, J., and Vereecken, H., 2007, Two-dimensional characterization of hydraulic heterogeneity by multiple pumping tests: Water Resources Research, v. 43, no. 4, W04433, doi:10.1029/2006WR005333.

Li, W., Englert, A., Cirpka, O.A., and Vereecken, H., 2008, Three-dimensional geostatistical inversion of flowmeter and pumping test data: Ground Water, v. 46, no. 2, p. 193–201, doi:10.1111/j.1745-6584.2007.00419.x

Michalak, A.M., Bruhwiler, L., and Tans, P.P., 2004, A geostatistical approach to surface flux estimation of atmospheric trace gases: Journal of Geophysical Research, v. 109, no. D14, doi:10.1029/2003jd004422.

Michalak, A.M., and Kitanidis, P.K., 2002, Application of Bayesian inference methods to inverse modeling for contaminant source identification at Gloucester Landfill, Canada: Amsterdam, Elsevier, Computational Methods in Water Resources 14, .

Michalak, A.M., and Kitanidis, P.K., 2003, A method for enforcing parameter nonnegativity in Bayesian inverse problems with an application to contaminant source identification: Water Resources Research, v. 39, no. 2, 1033, doi:10.1029/2002WR001480.

Mueller, K.L., Gourdji, S.M., and Michalak, A.M., 2008, Global monthly averaged CO2 fluxes recovered using a geostatistical inverse modeling approach; 1. Results using atmospheric measurements: Journal of Geophysical Research-Atmospheres, v. 113, no. D21, doi:10.1029/2007jd009734.

Muffels, C., Schreüder, W., Doherty, J., Karanovic, M., Tonkin, M., Hunt, R., and Welter, D., 2012, Approaches in highly parameterized inversion—GENIE, a general model-independent TCP/IP run manager, U.S. Geological Survey Techniques and Methods, book 7, chap. C6, 26 p.

Neupauer, R.M., and Wilson, J.L., 1999, Adjoint method for obtaining backward-in-time location and travel time probabilities of a conservative groundwater contaminant: Water Resources Research, v. 35, no. 11, p. 3389–3398.

Nowak, W., and Cirpka, O.A., 2004, A modified Levenberg-Marquardt algorithm for quasi-linear geostatistical inversing: Advances in Water Resources, v. 27, no. 7, p. 737–750, doi:10.1016/j.advwatres.2004.03.004.

R Development Core Team, 2011, R—A language and environment for statistical computing: Vienna, Austria, R Foundation for Statistical Computing, ISBN 3-900051-07-0.

RamaRao, B.S., Lavenue, A.M., de Marsily, G., and Marietta, M.G., 1995, Pilot point methodology for automated calibration of an ensemble of conditionally simulated transmissivity fields; 1. Theory and computational experiments: Water Resources Research, v. 31, no. 3, p. 475–493.

Remy, N., Boucher, A., and Wu, J., 2009, Applied geostatistics with SGeMS: Cambridge, UK; New York; Cambridge University Press, 264 p.

Robbins, H., 1956, An empirical Bayes approach to statistics, in Neyman, J., ed., Proceedings of the Third Berkeley Symposium on Mathematical Statistics: University of California Press, v. 1, p. 157–163.

Rubin, Y., 2003, Applied stochastic hydrogeology: Oxford, UK; New York; Oxford University Press, 391 p.

Samper, F.J., and Neuman, S., 1986, Adjoint state equations for advective-dispersive transport, in Sixth International Conference on Finite Elements in Water Resources, p. 423–437.

Schreüder, W., 2009, Running BeoPEST, in Proceedings, PEST Conference 2009, Potomac, Md., November 1–3, 2009: Bethesda, Md., S.S. Papadopulos and Associates, p. 228–240.

, P.:v.p.

Snodgrass, M. and Kitanidis, P., 1998, Transmissivity identification through multi-directional aquifer stimulation: Stochastic Hydrology and Hydraulics, v. 12, no. 5, p. 299–316, doi:10.1007/s004770050023.

Swift, D.J.P., Parsons, B.S., Foyle, A., and Oertel, G.F., 2003, Between beds and sequences—Stratigraphic organization at intermediate scales in the Quaternary of the Virginia coast, USA: Sedimentology, v. 50, no. 1, p. 81–111, doi:10.1046/j.1365-3091.2003.00540.x.

Sykes, J.F., Wilson, J.L., and Andrews, R.W., 1985, Sensitivity analysis for steady state groundwater flow using adjoint operators: Water Resources Research, v. 21, no. 3, p. 359–371, doi:10.1029/WR021i003p00359.

Tikhonov, A.N., 1963a, Solution of incorrectly formulated problems and the regularization method [in Russian]: Soviet Mathematics Doklady, v. 4, p. 1035–1038.

Tikhonov, A.N., 1963b, Regularization of incorrectly posed problems [in Russian]: Soviet Mathematics Doklady, v. 4, p. 1624–1637.

Townley, L., and Wilson, J., 1985, Computationally efficient algorithms for parameter estimation and uncertainty propagation in numerical models of groundwater flow: Water Resources Research, v. 21, no. 12, p. 1851–1860.

Walker, R.G., 1984, General introduction —Facies, facies sequences and facies models, chap. 1 of Walker, R.G., Facies models (2d ed.): Toronto, Geological Association of Canada, p. 1–9.

Walker, R.G., 1992, Facies, facies models and modern stratigraphic concepts, chap. 1 of Walker, R.G., and James, N.P., Facies models—Response to sea level change: St. John’s, Newfoundland, Geological Association of Canada, p. 1–14.

Westenbroek, S., Doherty, J., Walker, J., Kelson, V., Hunt, R., and Cera, T., 2012, Approaches in highly parameterized inversion—TSPROC, a general time-series processor to assist in model calibration and result summarization: U.S. Geological Survey Techniques and Methods, book 7, chap. C7, xx p.

# Appendix 1

Banta, E.R., Poeter, E.P., Doherty, J.E., and Hill, M.C., 2006, JUPITER: Joint Universal Parameter IdenTification and Evaluation of Reliability—An application programming interface (API) for model analysis: U.S. Geological Survey Techniques and Methods, book 6, chap. E1, 268 p.

Doherty, J., 2010, PEST, Model-independent parameter estimation—Addendum to user manual (5th ed.): Brisbane, Australia, Watermark Numerical Computing.

# Appendix 2

Doherty, J., 2010, PEST, Model-independent parameter estimation—User manual (5th ed., with slight additions): Brisbane, Australia, Watermark Numerical Computing.

# Appendix 3

Box, G., and Cox, D. R., 1964, An analysis of transformations: Journal of the Royal Statistical Society, series B (Methodolodical), v. 26, no. 2, p. 211–252.

D’Oria, M., 2010, Characterization of aquifer hydraulic parameters—From Theis to hydraulic tomography: Universita` degli Studi di Parma, Ph.D. Dissertation, 153 p.

Fienen, M., Kitanidis, P., Watson, D., and Jardine, P., 2004, An application of Bayesian inverse methods to vertical deconvolution of hydraulic conductivity in a heterogeneous aquifer at Oak Ridge National Laboratory: Mathematical Geology, v. 36, no. 1, p. 101–126, doi:10.1023/B:MATG.0000016232.71993.bd.

Fienen, M.N., Clemo, T.M., and Kitanidis, P.K., 2008, An interactive Bayesian geostatistical inverse protocol for hydraulic tomography: Water Resources Research, v. 44, W00B01, doi:10.1029/2007WR006730.

Gaganis, P., and Smith, L., 2001, A Bayesian approach to the quantification of the effect of model error on the predictions of groundwater models: Water Resources Research, v. 37, no. 9, p. 2309–2322, doi:10.1029/2000WR000001.

Gallagher, M.R., and Doherty, J., 2007, Parameter interdependence and uncertainty induced by lumping in a hydrologic model: Water Resources Research, v. 43, no. 5, W05421, doi:10.1029/2006wr005347.

Gray, R., 2005, Toeplitz and circulant matrices—A review: Delft, The Netherlands, Now Publishers, 90 p.

Hoeksema, R.J., and Kitanidis, P.K., 1984, An application of the geostatistical approach to the inverse problem in two-dimensional groundwater modeling: Water Resources Research, v. 20, no. 7, p. 1003–1020, doi:10.1029/WR020i007p01003.

Kitanidis, P.K., 1995, Quasi-linear geostatistical theory for inversing: Water Resources Research, v. 31, no. 10, p. 2411–2419, doi:10.1029/95WR01945.

Kitanidis, P.K., 1996, Analytical expressions of conditional mean, covariance, and sample functions in geostatistics: Stochastic Hydrology and Hydraulics, v. 10, no. 4, 279–294, doi:10.1007/bf01581870.

Kitanidis, P.K., and Vomvoris, E.G., 1983, A geostatistical approach to the inverse problem in groundwater modeling (steady state) and one-dimensional simulations: Water Resources Research, v. 19, no. 3, p. 677–690, doi:10.1029/WR019i003p00677.

Li, W., and Cirpka, O.A., 2006, Efficient geostatistical inverse methods for structured and unstructured grids: Water Resources Research, v. 42, no. 6, W06402, doi:10.1029/2005WR004668.

Li, W., Englert, A., Cirpka, O.A., Vanderborght, J., and Vereecken, H., 2007, Two-dimensional characterization of hydraulic heterogeneity by multiple pumping tests: Water Resources Research, v. 43, no. 4, W04433, doi:10.1029/2006WR005333.

Nowak, W., and Cirpka, O.A., 2004, A modified Levenberg-Marquardt algorithm for quasi-linear geostatistical inversing: Advances in Water Resources, v. 27, no. 7, p. 737–750, doi:10.1016/j.advwatres.2004.03.004.

Nowak, W., Tenkleve, S., and Cirpka, O.A., 2003, Efficient computation of linearized cross-covariance and auto-covariance matrices of interdependent quantities: Mathematical Geology, v. 35, no. 1, p. 53–66.

Press, W.H., Teukolsky, S.A., Vetterling, W.T., and Flannery, B.O., 1992, Numerical recipes in C—The art of scientific computing (2d ed.): Cambridge, UK; New York; Cambridge University Press, 994 p.

Rubin, Y., 2003, Applied stochastic hydrogeology, Oxford, UK; New York; Oxford University Press, 391 p.

# Appendix 4

Fienen, M.N., Clemo, T.M., and Kitanidis, P.K., 2008, An interactive Bayesian geostatistical inverse protocol for hydraulic tomography: Water Resources Research, v. 44, W00B01, doi:10.1029/2007WR006730.

# Appendix 6

D’Oria, M., and Tanda, M.G., in press, Reverse flow routing in open channels—A Bayesian Geostatistical Approach: Journal of Hydrology.

Faeh, R., Mueller, R., Rousselot, P., Vetsch, D., Volz, C., Vonwiller, L.R.V., and Farshi, D., 2011, System manuals of BASEMENT, version 2.1: Zurich, Switzerland, ETH Zurich Laboratory of Hydraulics, Glaciology and Hydrology (VAW).