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# A Global Database of Soil Phosphorus Compiled from Studies Using Hedley Fractionation

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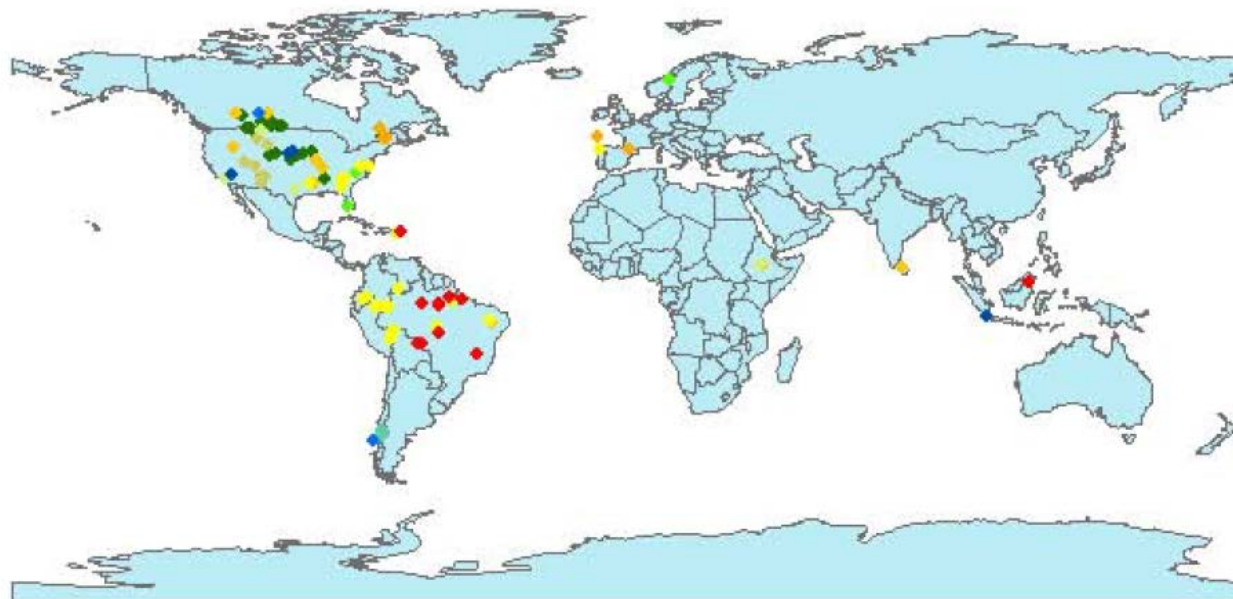
Revision Date: July 15, 2014

## Summary:

This data set provides concentrations of soil phosphorus (P) compiled from the peer-reviewed literature that cited the Hedley fractionation method (Hedley and Stewart, 1982). This database contains estimates of different forms of naturally occurring soil phosphorus, including labile inorganic P, organic P, occluded P, secondary mineral P, apatite P, and total P, based on the analyses of the various Hedley soil fractions.

The recent literature survey (Yang and Post, 2011) was restricted to studies of natural, unfertilized, and uncultivated soils since 1995. Ninety measurements of soil P fractions were identified. These were added to the 88 values from soils in natural ecosystems that Cross and Schlesinger (1995) had compiled. Cross and Schlesinger provided a comprehensive survey on Hedley P data prior to 1995. Measurement data are provided for studies published from 1985 through 2010.

In addition to the Hedley P fraction measurement data this data set includes soil order, soil pH, organic carbon and nitrogen content, as well as the geographic location (longitude and latitude) of the measurement sites. The spatial distribution of the sites is shown in Fig. 1. There is one comma separated (.csv) data file.



### Legend

● Alfisol	◆ Entisol	◆ Mollisol	● Ultisol
◆ Andisol	● Histisol	◆ Oxisol	● Vertisol
● Aridisol	◆ Inceptisol	● Spodosol	

Figure 1. Distribution of measurement sites. The legend identifies the USDA major soil order of the soils at a location. Some locations contain multiple data entries.

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## Data and Documentation Access:

**Get Data:** [http://daac.ornl.gov/cgi-bin/dsviewer.pl?ds\\_id=1230](http://daac.ornl.gov/cgi-bin/dsviewer.pl?ds_id=1230)

Companion Documentation for this Data Set:

- The complete set of references for the compiled data is included as a companion file: [References\\_HedleyPdatabase.pdf](#)
- Yang, X. and W.M. Post. Phosphorus transformations as a function of pedogenesis: A synthesis of soil phosphorus data using Hedley fractionation method, *Biogeosciences*, 8, 2907-2916, doi:10.5194/bg-8-2907-2011. ([ftp://daac.ornl.gov/data/global\\_soil/Global\\_Phosphorus\\_Hedley\\_Fract/comp/References\\_HedleyPdatabase.pdf](ftp://daac.ornl.gov/data/global_soil/Global_Phosphorus_Hedley_Fract/comp/References_HedleyPdatabase.pdf))

## Data Citation:

**Cite this data set as follows:**

Yang, X., W.M. Post, P.E. Thornton, and A. Jain. 2014. A Global Database of Soil Phosphorus Compiled from Studies Using Hedley Fractionation. Data set. Available on-line [<http://daac.ornl.gov>] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, USA. <http://dx.doi.org/10.3334/ORNLDAAC/1230>

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## 1. Data Set Overview:

This data set provides concentrations of soil phosphorus (P) compiled from the peer-reviewed literature that cited the Hedley fractionation method (Hedley and Stewart, 1982). This database contains estimates of different forms of naturally occurring soil phosphorus, including labile inorganic P, organic P, occluded P, secondary mineral P, apatite P, and total P, based on the analyses of the various Hedley soil fractions.

The recent literature survey (Yang and Post, 2011) was restricted to studies of natural, unfertilized, and uncultivated soils since 1995. Ninety measurements of soil P fractions were identified. These were added to the 88 values from soils in natural ecosystems that Cross and Schlesinger (1995) had compiled. Cross and Schlesinger provided a comprehensive survey on Hedley P data prior to 1995. Measurement data are provided for studies published from 1985 through 2010.

In addition to the Hedley P fraction measurement data this data set includes soil order, soil pH, organic carbon and nitrogen content, as well as the geographic location (longitude and latitude) of the measurement sites.

## 2. Data Characteristics:

There is one comma separated (.csv) data file. Missing values are represented as -9999.

Table 1. Data file description: **HedleyP\_database\_20140708.csv**

Column	Column Name	Extraction Agent in Hedley Fractionation Method	Units/format	Description
1	Soil_Order			USDA major soil order
2	Resin_Pi	Resin strip in water	mg P kg <sup>-1</sup>	Labile Pi (mg P kg <sup>-1</sup> )
3	Bicarbonate_Pi	0.5 M NaHCO <sub>3</sub>	mg P kg <sup>-1</sup>	Labile Pi (mg P kg <sup>-1</sup> )
4	Hydroxide_Pi	0.1 M NaOH	mg P kg <sup>-1</sup>	Secondary mineral Pi: adsorped to surfaces of Al and Fe oxides (mg P kg <sup>-1</sup> )
5	Sonic_Pi	0.1 M NaOH and sonicate	mg P kg <sup>-1</sup>	Secondary mineral Pi: adsorped within surfaces of Al and Fe oxides (mg P kg <sup>-1</sup> )
6	Apatite_P	1 M HCl	mg P kg <sup>-1</sup>	Apatite P (mg P kg <sup>-1</sup> )
7	Residue_P	H <sub>2</sub> SO <sub>4</sub> and H <sub>2</sub> O <sub>2</sub>	mg P kg <sup>-1</sup>	Occluded P (mg P kg <sup>-1</sup> )
8	Bicarbonate_Po	0.5 M NaHCO <sub>3</sub>	mg P kg <sup>-1</sup>	Labile Po, easily mineralized (mg P kg <sup>-1</sup> )
9	Hydroxide_Po	0.1 M NaOH	mg P kg <sup>-1</sup>	Stable Po, involved with long term transformation of P in soils (mg P kg <sup>-1</sup> )
10	Sonic_Po	0.1 M NaOH and sonicate	mg P kg <sup>-1</sup>	Stable Po, involved with long term transformation of P in soils (mg P kg <sup>-1</sup> )
11	Total_P	Sum of fields 2–10	mg P kg <sup>-1</sup>	(mg P kg <sup>-1</sup> )
12	pH			Soil pH
13	Organic_C		%	Organic carbon content of soil
14	Total_N		%	Total nitrogen in soil
15	Latitude		decimal	Latitude, positive = north, negative = south
16	Longitude		decimal	Longitude, positive = east, negative = west
17	Reference			Author name and publication year. See reference companion file, References_HedleyPdatabase.pdf, for complete citation.

**Site boundaries:** (All latitude and longitude given in decimal degrees)

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Global	-117.861	117.596543	63.23363	-42.5

### Temporal Coverage

Measurement data are provided for studies published from 1985 through 2010. No specific sampling and analysis dates are provided.

## 3. Data Application and Derivation:

As described in Yang and Post, 2011, by analyzing the Hedley-labile P and vegetation P demand, the amount of labile P is much greater than vegetation demand, even in highly weathered soils commonly considered P limited. They concluded that labile P measured by Hedley fractionation method should not be defined as plant available P since most of this labile P likely ends up as immobilized by microbes. Analysis of the database also shows that carbon

(C) and nitrogen (N) in soil organic matter are closely linked in all soil orders, but P is decoupled from C and N in highly weathered soils with larger variations of nitrogen:organic P (N:Po) ratio and higher mean values of N:Po ratio, compared to slightly and intermediately weathered soils.

## 4. Quality Assessment:

Table 2. Percentage of P (mean  $\pm$  sd) in different fractions based on Hedley P database. From Yang et al., 2013..

Soil Order	Labile Pi	Secondary Pi	Apatite P	Occluded P	Organic P
Entisol	11 $\pm$ 8	5 $\pm$ 4	47 $\pm$ 20	22 $\pm$ 10	15 $\pm$ 8
Inceptisol	12 $\pm$ 7	7 $\pm$ 3	17 $\pm$ 13	23 $\pm$ 13	41 $\pm$ 22
Aridisol	8 $\pm$ 2	6 $\pm$ 3	64 $\pm$ 15	17 $\pm$ 7	5 $\pm$ 2
Vertisol	6 $\pm$ 3	6 $\pm$ 3	29 $\pm$ 12	47 $\pm$ 8	12 $\pm$ 3
Mollisol	5 $\pm$ 3	4 $\pm$ 2	28 $\pm$ 9	44 $\pm$ 7	19 $\pm$ 9
Alfisol	7 $\pm$ 3	11 $\pm$ 5	19 $\pm$ 11	38 $\pm$ 13	25 $\pm$ 12
Spodosol	7 $\pm$ 3	12 $\pm$ 7	9 $\pm$ 8	28 $\pm$ 15	44 $\pm$ 9
Ultisol	7 $\pm$ 5	14 $\pm$ 5	3 $\pm$ 4	50 $\pm$ 15	26 $\pm$ 7
Oxisol	6 $\pm$ 3	14 $\pm$ 5	1 $\pm$ 0	59 $\pm$ 12	20 $\pm$ 8

## 5. Data Acquisition Materials and Methods:

### Hedley Sequential Fractionation Method Literature Survey

This is an expansion of an earlier study (Cross and Schlesinger, 1995) that summarized Hedley P data and created a larger database that included 178 published Hedley fractionation P measurements.

This recent literature survey was restricted to studies of natural, unfertilized, and uncultivated soils since 1995. Ninety measurements of soil P fractions were identified and were added to the 88 values from soils in natural ecosystems that Cross and Schlesinger (1995) had compiled. Cross and Schlesinger provided a comprehensive survey on Hedley P data prior to 1995. Measurement data are provided for studies from 1985 through 2010. In addition to the Hedley P fraction measurement data we also compiled information on soil order, soil pH, organic carbon and nitrogen content, as well as the geographic location (longitude and latitude) of the measurement sites.

The Hedley sequential fractionation method (Hedley and Stewart, 1982; Tiessen and Moir, 1993) has gained considerable attention as a useful tool to examine different forms of soil P and provides a comprehensive assessment of available P in soils (Johnson et al., 2003).

## 6. Data Access:

These data are available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

### Data Archive Center:

Contact for Data Center Access Information:

E-mail: [uso@daac.ornl.gov](mailto:uso@daac.ornl.gov)

Telephone: +1 (865) 241-3952

## 7. References:

Cross, A. and Schlesinger, W.: A literature review and evaluation of the Hedley fractionation: Applications to the biogeochemical cycle of soil phosphorus in natural ecosystems, *Geoderma*, 64, 197–214, doi:10.1016/0016-7061(94)00023-4, 1995.

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[doi:10.5194/bg-10-2525-213](https://doi.org/10.5194/bg-10-2525-213), 2013.

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