



Food and Agriculture
Organization of the
United Nations

Standard operating procedure for soil calcium carbonate equivalent

Volumetric Calcimeter method



**Standard operating procedure for soil calcium
carbonate equivalent
Volumetric Calcimeter method**

Required citation:

FAO. 2020. *Standard operating procedure for soil calcium carbonate equivalent. Volumetric Calcimeter method.* Rome, FAO.

The designations employed and the presentation of material in this information product do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations (FAO) concerning the legal or development status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. The mention of specific companies or products of manufacturers, whether or not these have been patented, does not imply that these have been endorsed or recommended by FAO in preference to others of a similar nature that are not mentioned.

The views expressed in this information product are those of the author(s) and do not necessarily reflect the views or policies of FAO.

© FAO, 2020



Some rights reserved. This work is made available under the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 IGO licence (CC BY-NC-SA 3.0 IGO; <https://creativecommons.org/licenses/by-nc-sa/3.0/igo/legalcode>).

Under the terms of this licence, this work may be copied, redistributed and adapted for non-commercial purposes, provided that the work is appropriately cited. In any use of this work, there should be no suggestion that FAO endorses any specific organization, products or services. The use of the FAO logo is not permitted. If the work is adapted, then it must be licensed under the same or equivalent Creative Commons licence. If a translation of this work is created, it must include the following disclaimer along with the required citation: “This translation was not created by the Food and Agriculture Organization of the United Nations (FAO). FAO is not responsible for the content or accuracy of this translation. The original [Language] edition shall be the authoritative edition.”

Disputes arising under the licence that cannot be settled amicably will be resolved by mediation and arbitration as described in Article 8 of the licence except as otherwise provided herein. The applicable mediation rules will be the mediation rules of the World Intellectual Property Organization <http://www.wipo.int/amc/en/mediation/rules> and any arbitration will be conducted in accordance with the Arbitration Rules of the United Nations Commission on International Trade Law (UNCITRAL).

Third-party materials. Users wishing to reuse material from this work that is attributed to a third party, such as tables, figures or images, are responsible for determining whether permission is needed for that reuse and for obtaining permission from the copyright holder. The risk of claims resulting from infringement of any third-party-owned component in the work rests solely with the user.

Sales, rights and licensing. FAO information products are available on the FAO website (www.fao.org/publications) and can be purchased through publications-sales@fao.org. Requests for commercial use should be submitted via: www.fao.org/contact-us/licence-request. Queries regarding rights and licensing should be submitted to: copyright@fao.org.

Global Soil Laboratory Network GLOSOLAN	GLOSOLAN-SOP-04	
SOIL CALCIUM CARBONATE EQUIVALENT Volumetric Calcimeter Method	Version number : 2	Page 1 of 13
	Effective date : 1 March 2021	

SOIL CALCIUM CARBONATE EQUIVALENT

Volumetric Calcimeter Method

VERSION HISTORY

N°	Date	Description of the modification	Type of modification
01	28 October 2019	Review of the draft SOP at the 3rd GLOSOLAN meeting	Finalization of the SOP
02	1 March 2021	Units of measures updated as per the decisions made at the 4th GLOSOLAN meeting	Revision of the units of measure
03			
04			
Etc.			

Modify by	Revision	Approved Date	Validated Date
GLOSOLAN SOP Tech. W.G. Leaders: Karim Shahbazi, Islamic Republic of Iran	Karim Shahbazi, Islamic Republic of Iran	1 March 2021	1 March 2021

Global Soil Laboratory Network GLOSOLAN	GLOSOLAN-SOP-04	
SOIL CALCIUM CARBONATE EQUIVALENT Volumetric Calcimeter Method	Version number : 2	Page 2 of 13
	Effective date : 1 March 2021	

Contents

1. Introduction	3
2. Scope and field of application	4
3. Principle.....	4
4. Apparatus	4
5. Reagents and standards	5
6. Sample preparation	5
7. Procedure	5
7.1. Calibration of calcimeter	5
7.2. Determination of the total carbonate in soils	6
7.3. Technical remarks	6
8. Calculations	7
8.1. Calibration of calcimeter	7
8.2. Determination of carbonate in soils	7
9. Health and safety	7
10. Quality assurance and quality control	8
10.1. Accuracy test.....	8
10.2. Precision test.....	9
10.3. Control chart	9
11. References.....	10
12. Appendix I.— Calcimeter apparatus	11
13. Appendix II.—Acknowledgements.....	12
14. Appendix III.—List of authors	12
15. Appendix IV.—Contributing laboratories.....	12

Modify by	Revision	Approved Date	Validated Date
GLOSOLAN SOP Tech. W.G. Leaders: Karim Shahbazi, Islamic Republic of Iran	Karim Shahbazi, Islamic Republic of Iran	1 March 2021	1 March 2021

Global Soil Laboratory Network GLOSOLAN	GLOSOLAN-SOP-04	
SOIL CALCIUM CARBONATE EQUIVALENT Volumetric Calcimeter Method	Version number : 2	Page 3 of 13
	Effective date : 1 March 2021	

1. Introduction

Calcium carbonate (CaCO₃), dolomite [CaMg(CO₃)₂], and magnesian calcite [Ca_{1-y}Mg_yCO₃] are the most common carbonate minerals. They account for more than 90 percent of natural carbonates (Lal, 2006). Calcite is the dominant form in soil. Aragonite and siderite are also found in some specific soils. Carbonates are common in many soils of the world, especially arid, semi-arid, and subhumid soils (Lal, 2006). Their origin can be primary (inherited from lithogenic) or secondary (pedogenic) (Loeppert and Suarez, 1996).

The amount and distribution of carbonate are two of the most important factors influencing the physical, chemical, and biological properties of soils. For example, carbonates have a significant effect on soil pH, sorption-desorption, precipitation-dissolution, and cementation processes. Due to reactivity and alkaline character, the carbonate minerals act as a pH buffer. The pH of soils that contain carbonate ranges from 7.1 to 8.5 (Lal, 2006; Loeppert and Suarez, 1996). Carbonates precipitation on soil particles and pores may form layers (e.g., a calcic horizon) that prevent water movement within the soil profile. Certain layers may become hard and cemented (e.g., a petrocalcic horizon) and cause water to move laterally (Lal, 2006). The active carbonate surface may adsorb essential plant nutrients and adversely influence their availability for plants. Iron deficiency chlorosis in plants has been attributed to the interaction of Fe and HCO₃⁻ in calcareous soils (Inskeep and Bloom, 1987; Lindsay and Thorne, 1954). Sorption and desorption of heavy metals of environmental concern (e.g., Cd²⁺ and Pb²⁺) on carbonates affect the metals mobility and bioavailability (Lal, 2006).

Carbonates play an important role in the global carbon cycle, although their role in greenhouse emissions has not been well known (Lal *et al.*, 1999). Soils are the largest terrestrial C pool (approximately 1500 billion tones in organic form and 970 billion tones as inorganic carbonates) and are thus the third largest C reservoir in the world, after oceans and fossil fuels (Lal and Kimble, 2000).

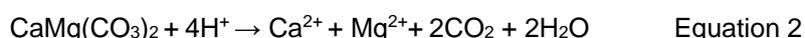
Calcium carbonate equiv. is used in soil classification as an index for a mollic epipedon, a calcic horizon, and the rendolls suborder. If free calcium carbonate is present in soil, the amount and depth are criteria for soil series identification. The accumulation and transportation of carbonates in the soil profile are used to identify and interpret soil formation processes (Soil Survey Staff, 2014).

In soils affected by carbonates, the content of calcium carbonate varies from negligible to more than 80 percent (Loeppert and Suarez, 1996). Calcium carbonate equivalents are determined if soil pH is above 7 or if effervescence is observed after treatment with 1M HCl. Carbonates are typically present in neutral to alkaline soils, but solid phase carbonates as nodules are also in some acid environments.

Soil carbonates are typically measured by dissolving carbonates in acid solution (equations 1 and 2) and then determining either H⁺ consumption, Ca and Mg production, or CO₂ production.



and



Modify by	Revision	Approved Date	Validated Date
GLOSOLAN SOP Tech. W.G. Leaders: Karim Shahbazi, Islamic Republic of Iran	Karim Shahbazi, Islamic Republic of Iran	1 March 2021	1 March 2021

Global Soil Laboratory Network GLOSOLAN	GLOSOLAN-SOP-04	
SOIL CALCIUM CARBONATE EQUIVALENT Volumetric Calcimeter Method	Version number : 2	Page 4 of 13
	Effective date : 1 March 2021	

2. Scope and field of application

This method estimates the amount of soil carbonate (as a percentage) by digestion with excess acid. The emitted CO₂ is determined using a volumetric calcimeter under constant pressure and temperature (appendix figure 1). This method is applicable to all soils; however, it may overestimate calcium carbonate equiv. in soils that have a high content of organic matter.

3. Principle

The carbonates are treated by hydrochloric acid (equations 1 and 2), and the volume of released carbon dioxide is measured. At constant temperature and pressure, the change in level of water in the system is a direct measure of the mass of CO₂ evolved and therefore of the soil carbonate decomposed. Different forms of calcimeter apparatus (e.g., Chittick, Scheibler, Bernard) are used for determination of calcium carbonate equiv. (CCE) based on volumetric method.

The volume of a given mass of CO₂ depends on both pressure and temperature. The solubility of CO₂ in water or acid depends not only on temperature and the partial pressure of CO₂ but also on the equilibrium between CO₂ gaseous and solution phases. Each specific calcimeter apparatus, therefore, must be calibrated under the defined conditions applied during the analysis (Loeppert and Suarez, 1996).

In the absence of decomposition of organic matter, the measurement of CO₂ production provides an absolute measure of carbonate. Precautions, however, are needed to ensure that organic matter oxidation does not interfere. Manganese dioxide in the soil can interfere with the acid dissolution procedures due to its influence on oxidation of organic matter. The release of CO₂ from organic matter can be minimized by the addition of FeCl₂ or FeSO₄ to the acid (Loeppert and Suarez, 1996). The solvation of CO₂ in displacement solution can be minimized by using the salted water or phosphoric acid (Allison, 1960). The addition of octyl alcohol practically eliminates the foaming that occurs if soils that have a high content of carbonate are treated with HCl (Bundy and Bremner, 1972).

4. Apparatus

1. Volumetric calcimeter. The principal components are: (A) 250-mL reaction flask, (B) 10-mL cup, (C) three-way stopcock, (D) burette, and (E) leveling bulb. Tubing connections can be made with Tygon tubing.
2. Magnetic stirrer
3. Electronic balance, ± 1.0 mg sensitivity
4. Analytical balance, ± 0.1 mg sensitivity
5. Volumetric dispenser, 10.00 mL, accuracy of ± 0.01 mL
6. 1000-mL volumetric flask

Modify by	Revision	Approved Date	Validated Date
GLOSOLAN SOP Tech. W.G. Leaders: Karim Shahbazi, Islamic Republic of Iran	Karim Shahbazi, Islamic Republic of Iran	1 March 2021	1 March 2021

Global Soil Laboratory Network GLOSOLAN	GLOSOLAN-SOP-04	
SOIL CALCIUM CARBONATE EQUIVALENT Volumetric Calcimeter Method	Version number : 2	Page 5 of 13
	Effective date : 1 March 2021	

5. Reagents and standards

1. Hydrochloric acid (HCl), 4 N. Add 393.3 mL of concentrated HCl (32%, sp. gr. 1.16) to 400 mL of deionized water. Dilute to a total volume of 1 L.
2. Filling solution. Make a 10%, by weight, sodium chloride (NaCl) solution by adding 100 g of NaCl to 1-L flask and diluting to a volume of 1 liter.
3. Reagent grade CaCO₃

6. Sample preparation

The soil samples should be air dried, ground, passed through a 10-mesh sieve (2 mm nominal pore size), and then to ensure the sample is uniform the sample, the sieved soil should be ground to very fine powder using suitable mortar.

7. Procedure

7.1. Calibration of calcimeter

- 7.1.1. Weigh dry, fine-grained, reagent-grade CaCO₃ to the nearest 0.1 mg into reaction flask (A). Samples of approximately 0.1000, 0.2000, 0.3000, 0.4000, 0.6000 g are recommended. Add 20 mL of deionized water and place a stirring bar in flask A.
- 7.1.2. Add 7 mL of acid solution to the cup (B).
- 7.1.3. Install the sample flask in the system. Open the three-way stopcock (C) to the atmosphere. Adjust the liquid level of the measuring burette (D) to exactly 0 mL by adjusting the height of the leveling bulb (E).
- 7.1.4. Close the system to the atmosphere with the three-way stopcock (C) (180° rotation). Lower the leveling bulb about 2 cm.
- 7.1.5. Simultaneously begin adding HCl solution from the cup (B) to the sample by tilting the flask and begin lowering the leveling bulb. The level of the liquid in the leveling bulb should be kept 1 to 2 cm below the level of the liquid in the measuring burette (D).
- 7.1.6. Turn on the magnetic stirrer (slow stirring rate). If a magnetic stirrer is not available, shake continuously by hand.
- 7.1.7. When the level in the gas burette stabilizes, then equalize the liquid levels in the leveling bulb (E) and the measuring burette (D). Read and record the volume of CO₂ that evolves.

Modify by	Revision	Approved Date	Validated Date
GLOSOLAN SOP Tech. W.G. Leaders: Karim Shahbazi, Islamic Republic of Iran	Karim Shahbazi, Islamic Republic of Iran	1 March 2021	1 March 2021

Global Soil Laboratory Network GLOSOLAN	GLOSOLAN-SOP-04	
SOIL CALCIUM CARBONATE EQUIVALENT Volumetric Calcimeter Method	Version number : 2	Page 6 of 13
	Effective date : 1 March 2021	

7.2. Determination of the total carbonate in soils

7.2.1. Add 0.5 to 5.0 g \pm 1 mg of soil sample (according to table 1) to the reaction flask.

Table 1. Sample Weight Estimation

Effervescence and appearance after adding HCl 1M	CaCO ₃ expected (%)	Sample weight (g)
Non, very slight, slight but for a short time	<8	5
Strong, bubbles form low foam	8–16	2.5
Violent, thick foam forms quickly	>16 [†]	1

[†]Note: If a soil contains 40 percent CaCO₃, or more, a 0.5 g sample should be weighed.

Repeat steps (7.1.2) through (7.1.7) for each unknown sample.

7.2.2. Repeat the previous steps for a blank sample (without soil) and a certified reference material (CRM) or quality control sample

7.3. Technical remarks

Samples, blanks, CRM, quality control sample and calcium carbonate used as standard material must be analyzed simultaneously in a room that has stable conditions for temperature and pressure.

The degree of CO₂ degassing from the digestion mixture is the major source of error in this method. Therefore, uniformity of procedure is essential, including volume of acid, agitation of the digestion mixture, and measuring time of CO₂ volume.

More water should be added to samples that have a high content of organic matter. The dilution decreases the oxidation of organic matter.

Foaming can be minimized by adding alcohol to those soil samples that have a high content of calcium carbonate.

Adding FeCl₂ or SnCl₂ (5% by weight) can minimize the oxidation of organic matter and the subsequent production of CO₂.

Carbonate minerals are rarely distributed uniformly in the soil; therefore, the samples used for carbonate analysis should be well ground and homogenized to minimize errors.

Most carbonates found in soil decompose rapidly in dilute acid; however, dolomite decomposes slowly in cold acid. Therefore, soils containing dolomite require a longer reaction time to ensure complete decomposition.

Modify by	Revision	Approved Date	Validated Date
GLOSOLAN SOP Tech. W.G. Leaders: Karim Shahbazi, Islamic Republic of Iran	Karim Shahbazi, Islamic Republic of Iran	1 March 2021	1 March 2021

Global Soil Laboratory Network GLOSOLAN	GLOSOLAN-SOP-04	
SOIL CALCIUM CARBONATE EQUIVALENT Volumetric Calcimeter Method	Version number : 2	Page 7 of 13
	Effective date : 1 March 2021	

8. Calculations

8.1. Calibration of calcimeter

- 8.1.1. Correct the CO₂ volume for the standards and samples by subtracting the CO₂ volumes for the blank as follows:

$$V_{CO_2(\text{corr})} = V_{CO_2} - V_{CO_2(\text{blank})} \quad \text{Equation 3}$$

- 8.1.2. Plotting calibration curve: plot actual CaCO₃(W_{CaCO₃}) on the y-axis vs. V_{CO₂(corr)} on the x-axis; Then, use linear regression to relate the corrected volume of CO₂ released to the mass of pure CaCO₃ and thus, derive the regression equation.

8.2. Determination of carbonate in soils

- 8.1.3. Calcium carbonate equiv. is calculated as follows:

$$CaCO_3 \text{ equiv., \%} = \left(\frac{W_{CaCO_3}}{W_{soil}} \right) \times 100 \quad \text{Equation 4}$$

Where:

W_{CaCO₃} = Weight of CaCO₃ calculated from the calibration curve (g) (8.1.2)

W_{soil} = Weight of soil (g)

9. Health and safety

Hydrochloric acid is corrosive. Causes severe skin burns and serious eye damage. Precautions should be taken. Keep away from open flames and heat sources. Measure the concentration of HCl in the air regularly. Carry out operations in a fume hood with exhaust ventilation. Never dilute by adding water to acid; always add the acid to the water.

Soils that have high CCE can cause pressure to build up and force the filling solution to overflow from the leveling bulb. Additionally, such soils might create enough pressure to damage the calcimeter.

Modify by	Revision	Approved Date	Validated Date
GLOSOLAN SOP Tech. W.G. Leaders: Karim Shahbazi, Islamic Republic of Iran	Karim Shahbazi, Islamic Republic of Iran	1 March 2021	1 March 2021

Global Soil Laboratory Network GLOSOLAN	GLOSOLAN-SOP-04	
SOIL CALCIUM CARBONATE EQUIVALENT Volumetric Calcimeter Method	Version number : 2	Page 8 of 13
	Effective date : 1 March 2021	

10. Quality assurance and quality control

10.1. Accuracy test

10.1.1. Recovery test

Analyze the certified reference material (CRM) in accordance with the standard operating procedure (SOP) of the particular parameter. Analyze the CRM sample in the same manner as the sample. Calculate the percent recovery based on equation 5. Compare result with the target recovery for the analyte concentration as indicated in Table 2, expected recovery as a function of analyte concentration (AOAC, 1998). If recovery test fails acceptance criteria, identify the root cause(s), develop corrective and preventive actions, and address the problem.

$$\text{Recovery, \%} = \frac{\text{mean of observed value}}{\text{true value}} \times 100 \quad \text{Equation 5}$$

Table 1. Expected recovery as a function of analyte concentration

Analyte, %	Analyte ratio	Unit	Mean recovery, %
100	1	100%	98–102
10	10 ⁻¹	10%	98–102
1	10 ⁻²	1%	97–103
0.01	10 ⁻³	0.1%	95–105
0.001	10 ⁻⁴	100 ppm	90–107
0.0001	10 ⁻⁵	10 ppm	80–110
0.00001	10 ⁻⁶	1 ppm	80–110
0.000001	10 ⁻⁷	100 ppb	80–110
0.0000001	10 ⁻⁸	10 ppb	60–115
0.00000001	10 ⁻⁹	1 ppb	40–120

10.1.2. Interlaboratory test

Participate in an interlaboratory proficiency test at least once a year. The PT z-score should be less than 2. If not, identify root cause(s), develop corrective and preventive actions, and address the problem.

Modify by	Revision	Approved Date	Validated Date
GLOSOLAN SOP Tech. W.G. Leaders: Karim Shahbazi, Islamic Republic of Iran	Karim Shahbazi, Islamic Republic of Iran	1 March 2021	1 March 2021

Global Soil Laboratory Network GLOSOLAN	GLOSOLAN-SOP-04	
SOIL CALCIUM CARBONATE EQUIVALENT Volumetric Calcimeter Method	Version number : 2	Page 9 of 13
	Effective date : 1 March 2021	

10.1.3. Analyze check reference

Perform replicate analyses of CRM with this reference method. Compare results from your laboratory with results from other laboratories as provided in the performance analysis report or CRM certificate. Your laboratory result is considered accurate when it is within the reported 95 percent confidence interval of the target value.

10.2. Precision test

Perform replicate analysis of 10 percent of samples in a test batch. Calculate the Percent Relative Standard Deviation (%RSD) to determine if the precision of replicate analyses is within specification. Compare result with the target precision for the analyte concentration as indicated in table 3, expected precision (repeatability) as a function of analyte concentration.

$$RSD, \% = \frac{S}{\bar{x}} \times 100 \quad \text{Equation 6}$$

Where:

S = Standard deviation of the replicate result

\bar{x} = Mean value

Table 2. Expected precision (repeatability) as a function of analyte concentration

Analyte, %	Analyte ratio	Unit	RSD, %
100	1	100%	1.3
10	10 ⁻¹	10%	1.9
1	10 ⁻²	1%	2.7
0.01	10 ⁻³	0.1%	3.7
0.001	10 ⁻⁴	100 ppm (mg/kg)	5.3
0.0001	10 ⁻⁵	10 ppm (mg/kg)	7.3
0.00001	10 ⁻⁶	1 ppm (mg/kg)	11
0.000001	10 ⁻⁷	100 ppb (µg/kg)	15
0.0000001	10 ⁻⁸	10 ppb (µg/kg)	21
0.00000001	10 ⁻⁹	1 ppb (µg/kg)	30

10.3. Control chart

Analyze at least one duplicate of the check sample or internal reference material in every batch analysis. Plot the result in the control chart. Monitor for results that are outside of the specified limits. If a result is observed out of the specified limit, identify the root cause(s), develop corrective and preventive actions, and address the problem.

Modify by	Revision	Approved Date	Validated Date
GLOSOLAN SOP Tech. W.G. Leaders: Karim Shahbazi, Islamic Republic of Iran	Karim Shahbazi, Islamic Republic of Iran	1 March 2021	1 March 2021

Global Soil Laboratory Network GLOSOLAN	GLOSOLAN-SOP-04	
SOIL CALCIUM CARBONATE EQUIVALENT Volumetric Calcimeter Method	Version number : 2	Page 10 of 13
	Effective date : 1 March 2021	

11. References

- Allison, L.** 1960. Wet-combustion apparatus and procedure for organic and inorganic carbon in soil. *Soil Science Society of America Journal*, 24: 36–40.
- AOAC.** 1998. *Peer Verified Methods Program. Manual on Policies and Procedures.* AOAC International Gathersburg. MD.
- Bundy, L. & Bremner, J.** 1972. A simple titrimetric method for determination of inorganic carbon in soils. *Soil Science Society of America Journal*, 36: 273–275.
- Inskeep, W.P. & Bloom, P.R.** 1987. Soil chemical factors associated with soybean chlorosis in Calciaquolls of western Minnesota. *Agronomy Journal*, 79: 779–786.
- Lal, R.** 2006. *Encyclopedia of soil science.* CRC Press, 1923 pp.
- Lal, R. & Kimble, J.** 2000. Inorganic carbon and the global C cycle: research and development priorities. *Global climate change and pedogenic carbonates.* pp. 291–302.
- Lal, R., Kimble, J.M., Stewart B. & Eswaran, H.** 1999. *Global climate change and pedogenic carbonates.* CRC Press, 325 pp.
- Lindsay, W.L. & Thorne, D.** 1954. Bicarbonate ion and oxygen level as related to chlorosis. *Soil Science*, 77: 271–280.
- Loeppert, R.H. & Suarez, D.L.** 1996. *Carbonate and gypsum.* Publications from USDA-ARS, UNL Faculty 504.
- Soil Survey Staff.** 2014. *Keys to soil taxonomy.* United States Department of Agriculture, Natural Resources Conservation Service.

Modify by	Revision	Approved Date	Validated Date
GLOSOLAN SOP Tech. W.G. Leaders: Karim Shahbazi, Islamic Republic of Iran	Karim Shahbazi, Islamic Republic of Iran	1 March 2021	1 March 2021

Global Soil Laboratory Network GLOSOLAN	GLOSOLAN-SOP-04	
SOIL CALCIUM CARBONATE EQUIVALENT Volumetric Calcimeter Method	Version number : 2	Page 11 of 13
	Effective date : 1 March 2021	

12. Appendix I.— Calcimeter apparatus

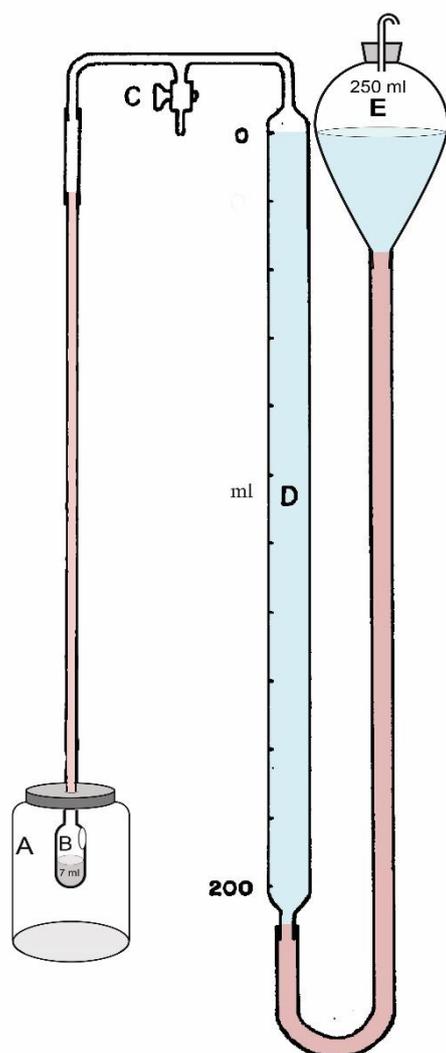


Figure 1. Calcimeter apparatus

Modify by	Revision	Approved Date	Validated Date
GLOSOLAN SOP Tech. W.G. Leaders: Karim Shahbazi, Islamic Republic of Iran	Karim Shahbazi, Islamic Republic of Iran	1 March 2021	1 March 2021

Global Soil Laboratory Network GLOSOLAN	GLOSOLAN-SOP-04	
SOIL CALCIUM CARBONATE EQUIVALENT Volumetric Calcimeter Method	Version number : 2	Page 12 of 13
	Effective date : 1 March 2021	

13. Appendix II.—Acknowledgements

GLOSOLAN thanks Mr. Karim Shahbazi for leading the harmonization of this SOP and the USDA for proof reading the document. GLOSOLAN also thanks Mostafa Marzi, Neda Bahaelou Houreh and Mehdi Beheshti from the Soil and Water Research Institute laboratory of the Islamic Republic of Iran for their contribution to the writing of this SOP, and participants in the 3rd GLOSOLAN meeting (28-30 October 2019) for reviewing it. Ultimately, GLOSOLAN thanks Ms. Nopmanee Suvannang, GLOSOLAN Chair for her contribution to the overall writing of this SOP.

14. Appendix III.—List of authors

Main authors (in alphabetical order):

- Mr. Karim Shahbazi, Soil and Water Research Institute laboratory, **Islamic Republic of Iran**
- Ms. Marija Romić, University of Zagreb Faculty of Agriculture, Analytical Laboratory of the Department of Soil Amelioration, **Croatia**
- Mr. Richard Ferguson, Kellogg Soil Survey Laboratory, **United States of America**
- Ms. Nopmanee Suvannang, GLOSOLAN Chair, **Thailand**

15. Appendix IV.—Contributing laboratories

GLOSOLAN thanks the following laboratories for completing the GLOSOLAN form on the method and providing information on their standard operating procedure for the calcium carbonate equiv. volumetric calcimeter method. This information was used as a baseline for the global harmonization.

From the Asian region:

- None. Laboratories in Asia stated not to measure calcium carbonate in soil

From the Pacific region:

- None

From the Near East and North African (NENA) region:

- Soil and Water Research Institute Laboratory (SWRI-Lab), **Islamic Republic of Iran**
- Central Analysis Soil Laboratory (LCAS), **Tunisia**

The majority of soil laboratories in NENA stated not to use this method.

From the African region:

- Laboratoire des Moyens Analytiques (LAMA), **Senegal**

The majority of soil laboratories in Africa stated not to use this method.

Modify by	Revision	Approved Date	Validated Date
GLOSOLAN SOP Tech. W.G. Leaders: Karim Shahbazi, Islamic Republic of Iran	Karim Shahbazi, Islamic Republic of Iran	1 March 2021	1 March 2021

Global Soil Laboratory Network GLOSOLAN	GLOSOLAN-SOP-04	
SOIL CALCIUM CARBONATE EQUIVALENT Volumetric Calcimeter Method	Version number : 2	Page 13 of 13
	Effective date : 1 March 2021	

From the European region:

- Bundesamt für Wasserwirtschaft Institut für Kulturtechnik, **Austria**
- University of Zagreb, Faculty of Agriculture, Department of General Agronomy, **Croatia**
- Aarhus University, AGRO University laboratory, **Denmark**
- Eco&Sols, **France**
- Food Chain Safety Centre Non-profit Ltd., **Hungary**

From the Eurasian region:

- Institute of Biology of Komi Scientific Center of the Ural Branch, **Russian Federation**

From Latin America:

- Laboratorio de Suelos DGRN-MGAP, **Uruguay**

From North America:

- Kellogg Soil Survey Laboratory, **United States**

Modify by	Revision	Approved Date	Validated Date
GLOSOLAN SOP Tech. W.G. Leaders: Karim Shahbazi, Islamic Republic of Iran	Karim Shahbazi, Islamic Republic of Iran	1 March 2021	1 March 2021



The Global Soil Partnership (GSP) is a globally recognized mechanism established in 2012. Our mission is to position soils in the Global Agenda through collective action. Our key objectives are to promote Sustainable Soil Management (SSM) and improve soil governance to guarantee healthy and productive soils, and support the provision of essential ecosystem services towards food security and improved nutrition, climate change adaptation and mitigation, and sustainable development.

**GLOSOLAN
GLOBAL SOIL LABORATORY NETWORK**

GLOSOLAN is a Global Soil Laboratory Network which aims to harmonize soil analysis methods and data so that soil information is comparable and interpretable across laboratories, countries and regions. Established in 2017, it facilitates networking and capacity development through cooperation and information sharing between soil laboratories with different levels of experience. Joining GLOSOLAN is a unique opportunity to invest in quality soil laboratory data for a sustainable and food secure world.

Thanks to the financial support of

